ENGINEERS POCKETBOOK
BAC ONE-ELEVEN

CONTENTS

GROUP 2 SYSTEMS

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AIR

General

The pneumatic system provides duplicated charge-air supplies of correct pressure and temperature for the air-conditioning and pressurization system, and for the airframe anti-icing system.

The associated controls and indicators are located in the flight deck on the AIR SYSTEM and ANTI-ICING SYSTEM sections of the centre roof panel E, on panel A, and on the right-hand console.

Both the pneumatic and air-conditioning systems are duplicated; the failure of any one system will not result in a loss of pressurization or air-conditioning.

Air is also supplied by the pneumatic system for engine anti-icing, fuel heating, thrust reversal, the constant speed drive and starter unit (CSDS), generator cooling, the hydraulic reservoir and the water/waste system; also the water injection system.

Charge air may be taken from one or both engines, from the auxiliary power unit (APU), or when the aircraft is on the ground, from an external supply.

Refer to Section 2-11-0 for the airframe anti-ice system.

PNEUMATIC SYSTEMS

The duplicated pneumatic systems are identical, with the exception of a ground start connection in No.2 (right-hand) system and a connection from the APU fitted into No.1 (left-hand) system; therefore only No.1 system is described.

High temperature, high pressure (HP) air is bled from the final stage of the engine HP compressor and passed through a manifold and into an engine cross-over duct which incorporates tappings for the CSDS, engine anti-icing, generator cooling, fuel heating and thrust reversal. From the cross-over duct, the HP air passes through an elbow duct which incorporates the hydraulic reservoir tapping, and into the HP duct located in the stub fairing.

Fitted in the HP duct is the shut-off (isolation) valve, which isolates the engine HP air supply from the distribution system if closed. The valve may be closed by manual selection or automatically if over-pressure, over-temperature or stub duct failure are detected in the system.

A tapping from the valve provides an air supply for the water injection system.

Also fitted in the HP ducting are the pressure reducing valve and the duct relief valve which will 'blow out' if the duct pressure becomes excessive. The HP duct then passes the HP air into the primary main heat exchanger.

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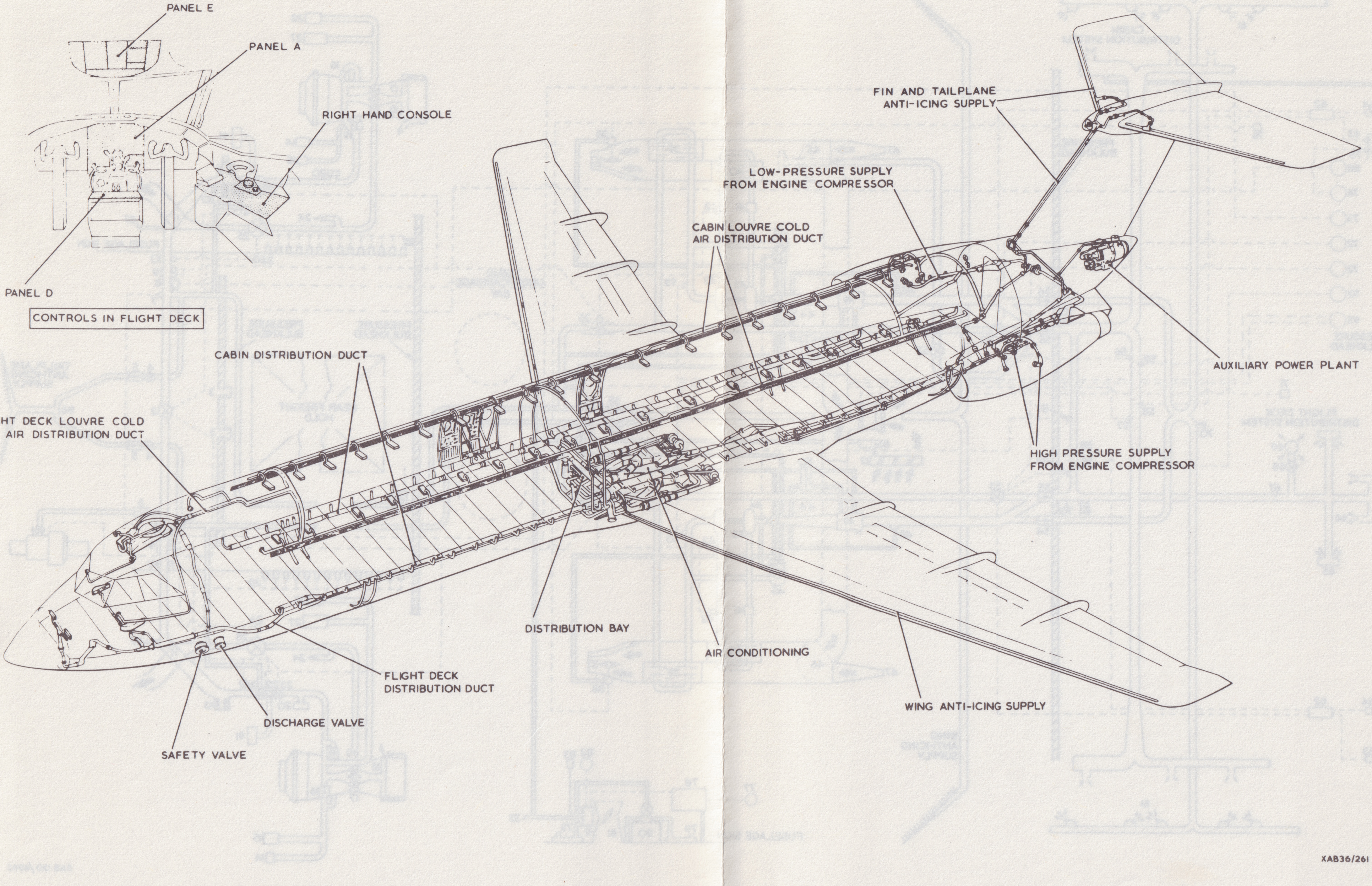
Low pressure (LP) air bled from the final stage of the engine LP compressor and passed inboard to the LP air duct in the stub fairing. A tapping in the LP air duct provides air for a jet pump which induces atmospheric air for cooling into Zone B of the stub fairing. Fitted in the LP duct is the temperature control valve; this, operating in response to electrical signals from a temperature controller and an anticipator and temperature sensor unit, regulates the flow of cooling LP air passing through the heat exchanger.

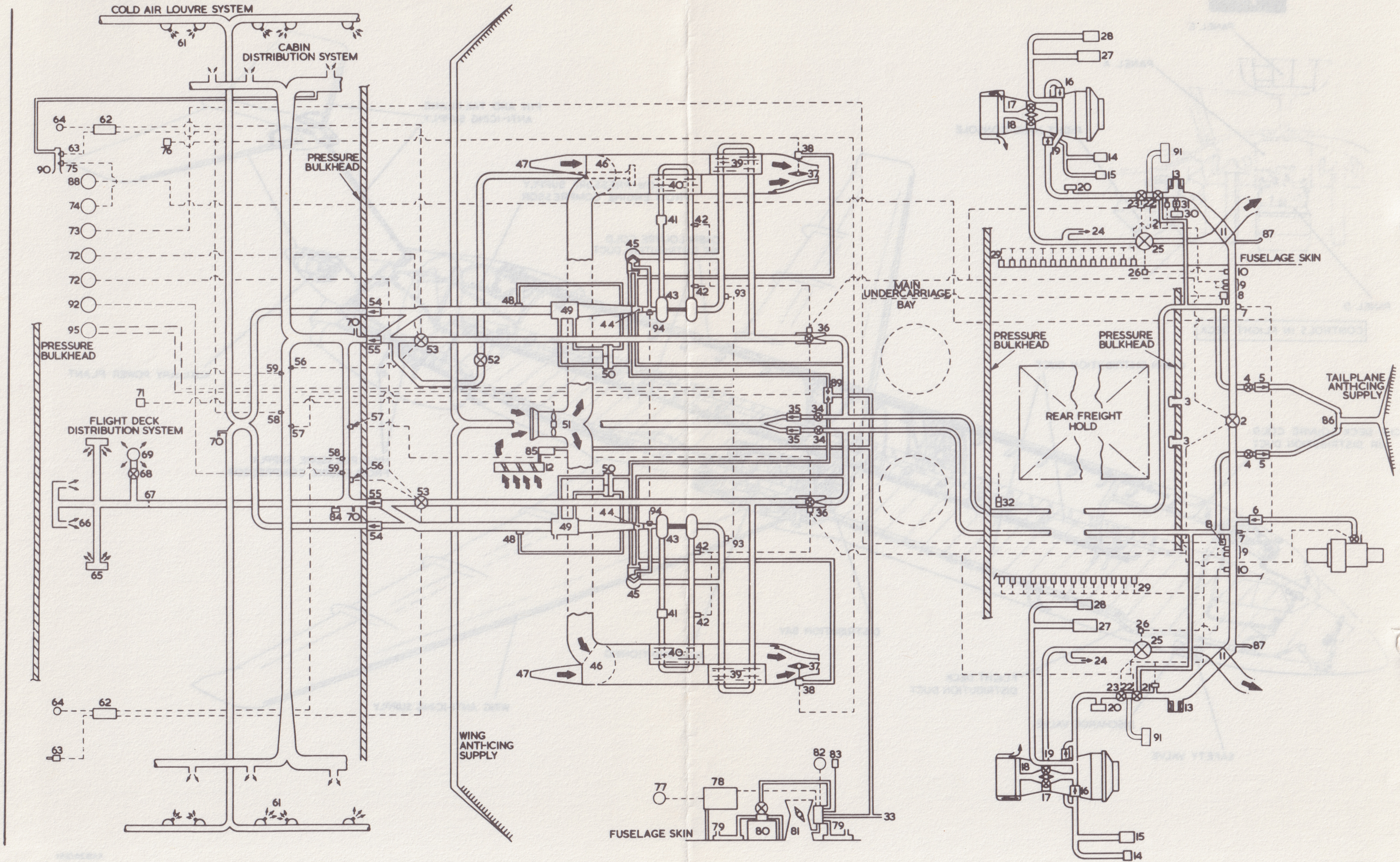
The primary main heat exchanger fitted in the HP ducting is a cross-flow, single pass, corrugated matrix type. The HP charge-air and the cooling LP air pass in alternate 'layers', the exit temperature of the charge-air being governed by the volume of LP air passed.

Downstream of the heat exchanger the distribution duct bifurcates; one arm, incorporating the APU supply inlet, interconnects with No.2 system supply duct via the cross-feed shut-off valve; the valve is opened when APU air is supplied to the aircraft systems or during the engine starting sequence. The other arm passes forward together with the No.2 supply duct to form the main distribution ducts for the associated aircraft systems.


PANEL E
PANEL A
RIGHT HAND CONSOLE
PANEL D
CONTROLS IN FLIGHT DECK
FIN AND TAILPLANE ANTI-ICING SUPPLY
LOW-PRESSURE SUPPLY FROM ENGINE COMPRESSOR
CABIN LOUVRE COLD AIR DISTRIBUTION DUCT
CABIN DISTRIBUTION DUCT
AUXILIARY POWER PLANT
FLIGHT DECK LOUVRE COLD AIR DISTRIBUTION DUCT
HIGH PRESSURE SUPPLY FROM ENGINE COMPRESSOR
DISTRIBUTION BAY
AIR CONDITIONING
FLIGHT DECK DISTRIBUTION DUCT
WING ANTI-ICING SUPPLY
DISCHARGE VALVE
SAFETY VALVE
XAB36/261

G.A. of Air Systems
Figure 1

BC700126


COLD AIR LOUVRE SYSTEM
CABIN DISTRIBUTION SYSTEM
PRESSURE BULKHEAD
PRESSURE BULKHEAD
FLIGHT DECK DISTRIBUTION SYSTEM
WING ANTI-ICING SUPPLY
FUSELAGE SKIN
MAIN UNDERCARRIAGE BAY
PRESSURE BULKHEAD
PRESSURE BULKHEAD
REAR FREIGHT HOLD
FUSELAGE SKIN
TAILPLANE ANTHCING SUPPLY
XAB 00/4965
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95

Air Systems Diagram
Figure 2

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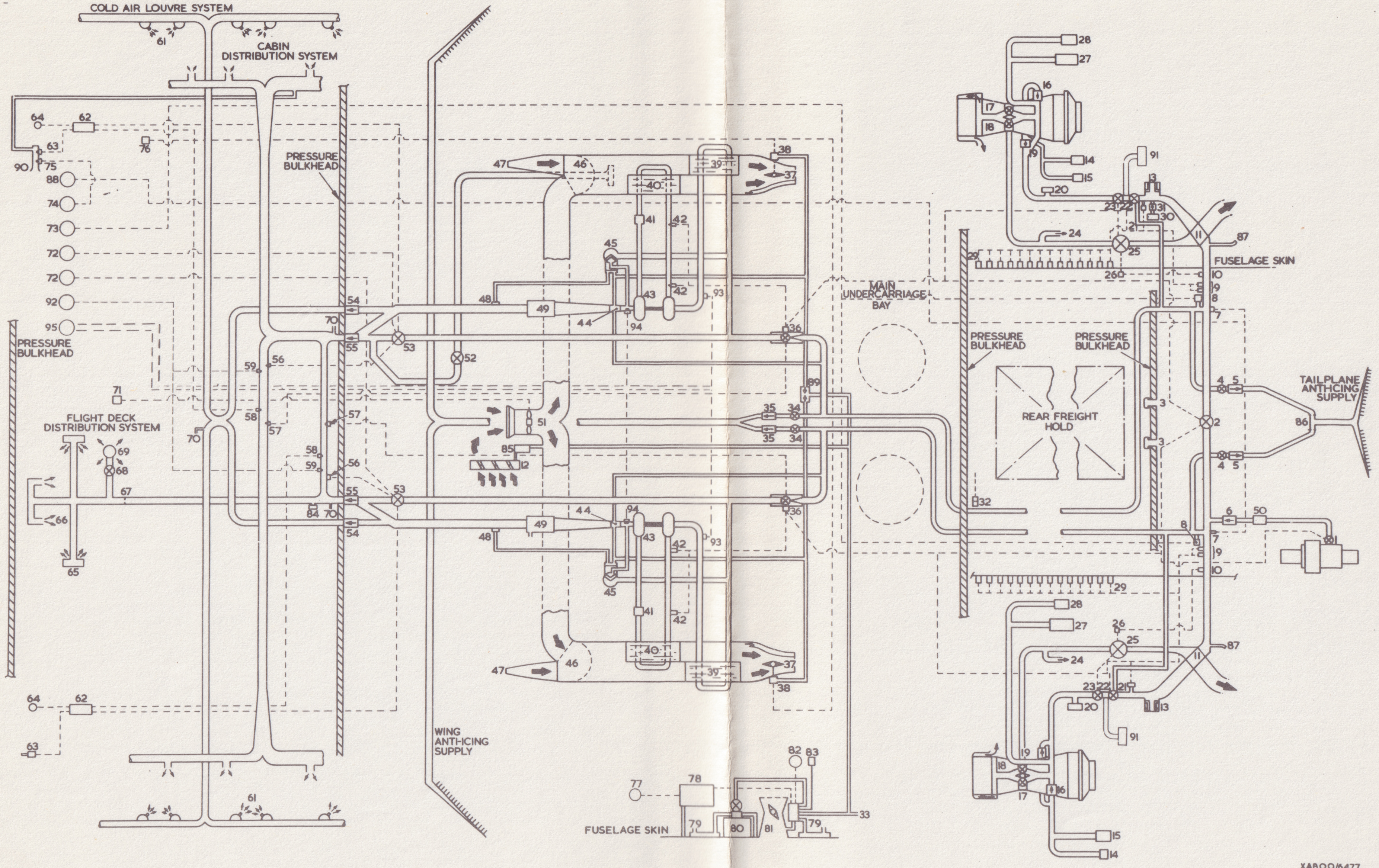

COLD AIR LOUVRE SYSTEM
CABIN DISTRIBUTION SYSTEM
PRESSURE BULKHEAD
PRESSURE BULKHEAD
FLIGHT DECK DISTRIBUTION SYSTEM
WING ANTI-ICING SUPPLY
MAIN UNDERCARRIAGE BAY
PRESSURE BULKHEAD
PRESSURE BULKHEAD
REAR FREIGHT HOLD
FUSELAGE SKIN
TAILPLANE ANTI-ICING SUPPLY
FUSELAGE SKIN
XABOO/6477

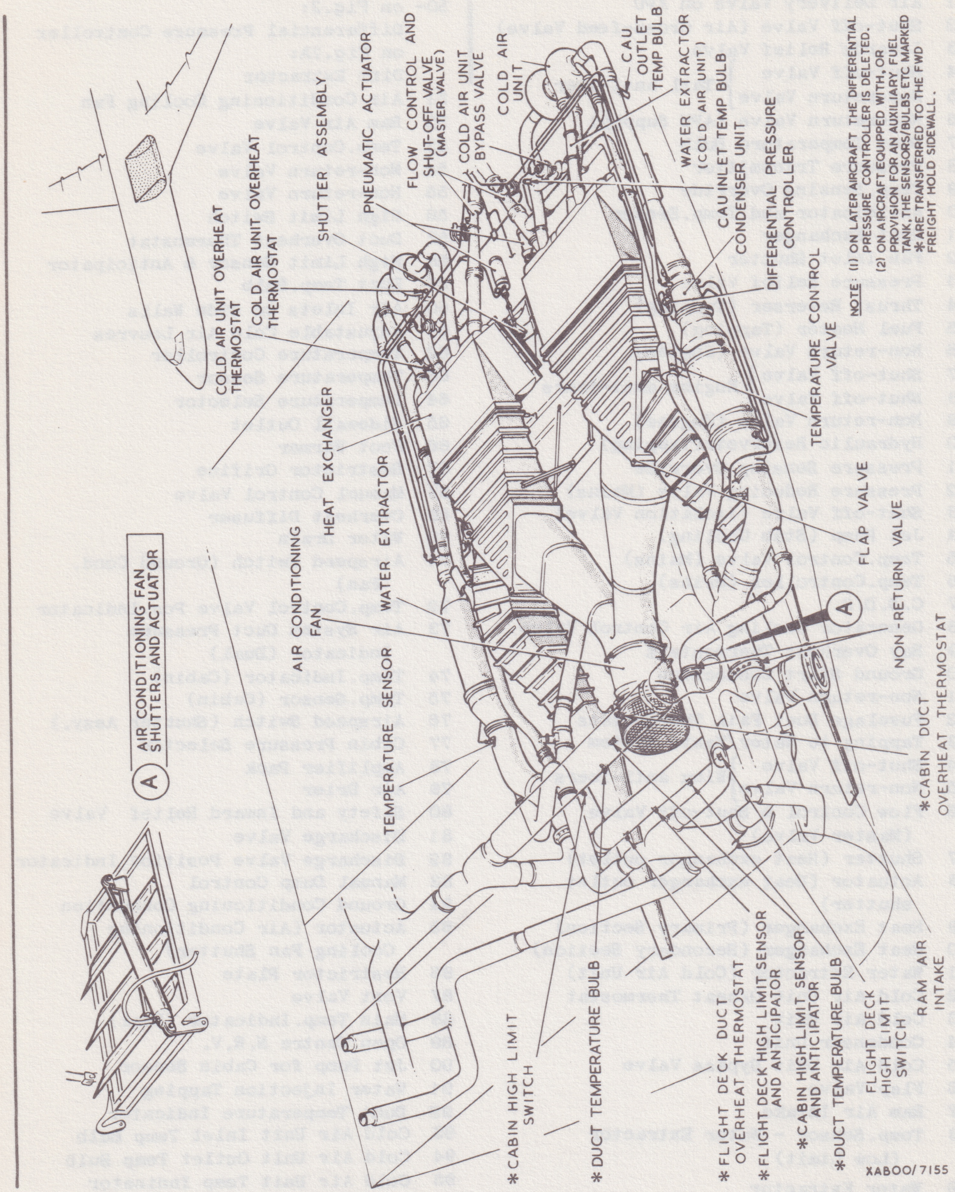
Air Systems Diagram
(Later Aircraft - Differential Pressure
Controller deleted)
Figure 2A

X028354

1 Air Delivery Valve on APU
2 Shut-off Valve (Air Cross-feed Valve)
3 Inwards Relief Valve
4 Shut-off Valve }
5 Non-return Valve } Tail anti-icer
6 Non-return Valve (APU Supply)
7 Duct Temperature Bulb
8 Pressure Transmitter
9 Temp. Sensing Override
10 Anticipator and Temp. Sensor
11 Heat Exchanger
12 Fan Inlet Shutter
13 Pressure Relief Valve
14 Thrust Reverser (Tapping)
15 Fuel Heater (Tapping)
16 Non-return Valve (Engine)
17 Shut-off Valve }
18 Shut-off Valve } Engine anti-icers
19 Non-return Valve (Engine)
20 Hydraulic Reservoir (Tapping)
21 Pressure Sensing Override
22 Pressure Reducing Valve (Mains)
23 Shut-off Valve (Isolation Valve)
24 Jet Pump (Stub Cooling)
25 Temp. Control Valve (Mains)
26 Temp. Controller (Mains)
27 C.S.D.S.
28 Generator Cooling Air Control Valve
29 Bay Overheat Thermostats
30 Ground Start Connection
31 Non-return Valve
32 Fuselage Duct Fail Thermostats
33 Tapping to Water/Waste System
34 Shut-off Valve }
35 Non-return Valve } Wing anti-icers
36 Flow Control & Shut-off Valve (Master Valve)
37 Shutter (Heat exchanger outlet)
38 Actuator (Heat exchanger outlet shutter)
39 Heat Exchanger (Primary Section)
40 Heat Exchanger (Secondary Section)
41 Water Extractor (Cold Air Unit)
42 Cold Air Unit O/heat Thermostat
43 Cold Air Unit
44 Condenser Unit
45 Cold Air Unit Bypass Valve
46 Flap Valve
47 Ram Air Intake
48 Temp. Sensor - Water Extractor (Low Limit)
49 Water Extractor

50- on Fig.2: Differential Pressure Controller
on Fig.2A: Dirt Extractor
51 Air Conditioning Cooling Fan
52 Ram Air Valve
53 Temp. Control Valve
54 Non-return Valve
55 Non-return Valve
56 High Limit Switch
57 Duct Overheat Thermostat
58 High Limit Sensor & Anticipator
59 Duct Temp. Bulb
60 Air Inlets to Side Walls
61 Adjustable Cold Air Louvres
62 Temperature Controller
63 Temperature Sensor
64 Temperature Selector
65 Sidewall Outlet
66 Foot Warmer
67 Restrictor Orifice
68 Manual Control Valve
69 Overheat Diffuser
70 Water Drain
71 Airspeed Switch (Ground Cond. Fan)
72 Temp. Control Valve Pos. Indicator
73 Air System Duct Pressure Indicator (Dual)
74 Temp. Indicator (Cabin)
75 Temp. Sensor (Cabin)
76 Airspeed Switch (Shutter Assy.)
77 Cabin Pressure Selector
78 Amplifier Pack
79 Air Drier
80 Safety and Inward Relief Valve
81 Discharge Valve
82 Discharge Valve Position Indicator
83 Manual Dump Control
84 Ground Conditioning Connection
85 Actuator (Air Conditioning Cooling Fan Shutter)
86 Restrictor Plate
87 Vent Valve
88 Main Temp. Indicator (Dual)
89 Open Centre N.R.V.
90 Jet Pump for Cabin Sensor
91 Water Injection Tapping
92 Duct Temperature Indicator
93 Cold Air Unit Inlet Temp Bulb
94 Cold Air Unit Outlet Temp Bulb
95 Cold Air Unit Temp Indicator

Key to Figures 2 and 2A


A AIR CONDITIONING FAN SHUTTERS AND ACTUATOR
COLD AIR UNIT OVERHEAT THERMOSTAT
COLD AIR UNIT OVERHEAT THERMOSTAT
SHUTTER ASSEMBLY
PNEUMATIC ACTUATOR
FLOW CONTROL AND SHUT-OFF VALVE (MASTER VALVE)
COLD AIR UNIT BYPASS VALVE
COLD AIR UNIT
CAU OUTLET TEMP BULB
WATER EXTRACTOR (COLD AIR UNIT)
CAU INLET TEMP BULB
CONDENSER UNIT
DIFFERENTIAL PRESSURE CONTROLLER
TEMPERATURE CONTROL VALVE
HEAT EXCHANGER
AIR CONDITIONING FAN
WATER EXTRACTOR
TEMPERATURE SENSOR
FLAP VALVE
NON RETURN VALVE
A
*CABIN DUCT OVERHEAT THERMOSTAT
*CABIN HIGH LIMIT SWITCH
*DUCT TEMPERATURE BULB
*FLIGHT DECK DUCT OVERHEAT THERMOSTAT
*FLIGHT DECK HIGH LIMIT SENSOR AND ANTICIPATOR
*CABIN HIGH LIMIT SENSOR AND ANTICIPATOR
*DUCT TEMPERATURE BULB
FLIGHT DECK HIGH LIMIT SWITCH
RAM AIR INTAKE
XABOO/7155

NOTE (1) ON LATER AIRCRAFT THE DIFFERENTIAL PRESSURE CONTROLLER IS DELETED.
(2) ON AIRCRAFT EQUIPPED WITH, OR PROVISION FOR AN AUXILIARY FUEL TANK, THE SENSORS/BULBS ETC MARKED * ARE TRANSFERRED TO THE FWD FREIGHT HOLD SIDEWALL.

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Ducting and Equipment in Air Conditioning and Equipment Bays

Figure 3

AIR CONDITIONING And PRESSURIZATION SYSTEM

The function of the system is to provide a comfortable level of pressure and temperature, together with adequate ventilation, in the flight deck and passenger cabin. The complete fuselage—is pressurized with the exception of the radome, the centre-section torque box, the main and nose undercarriage bays, and the tail section.

The duplicated supplies of hot air provided by the pneumatic system are passed through individual, automatically controlled air conditioning equipment, then interconnected for distribution. Interconnection enables both the left-hand (flight deck) and the right-hand (Passenger cabin) distribution systems to function with only one supply system operating, and also permits air in excess of flight deck requirements to supplement the passenger cabin supply.

The two air-conditioning systems are identical, therefore only one is described.

Hot charge air from the pneumatic system passes through the flow control and shut-off valve (master valve) and enters a bifurcated duct, one branch incorporates the temperature control valve, which governs the proportion of hot air passed directly to the air mixing duct. The other branch directs the remaining air into the air cycle refrigeration equipment, which consists basically of a two stage heat exchanger, a cold air unit, bypass valve and a water extractor.

The heat exchanger is cooled by air, ducted either from a ram air intake or from an electrically driven ground conditioning fan, a hinged flap valve cuts off the cooling duct not in use. Both fan and shutter operation is automatically controlled, the shutter may also be closed by moving the FAN INTAKE switch from AUTO to SHUT. The cold air unit consists of an inward flow radial turbine which drives a centrifugal compressor; both are mounted on a common shaft.

Charge air entering the refrigeration equipment is passed through the primary section of the heat exchanger and into a bifurcated duct; one branch passes air to the cold air unit compressor; the other branch incorporates the cold air unit bypass valve which automatically diverts warm air to disperse any ice that may form in the main water extractor.

Air increased in temperature and pressure by the cold air unit compressor is directed through the secondary section of the heat exchanger for cooling, then passed, via a small water extractor, to the cold air unit turbine.

The turbine further reduces the temperature and pressure of the air by extracting energy to drive the compressor.

Cold air from the turbine passes through the main water extractor and into the extractor outlet duct, which is bifurcated; one branch directs the cold air into the air mixing duct, the other branch passes cold air through a non-return valve and into the cold air plenum duct.

Conditioned air for the passenger cabin is tapped from the right-hand air mixing duct and passed, via a non-return valve, into a bifurcated duct located in the distribution bay. One branch of the duct is interconnected with the flight deck distribution system, the other branch is further bifurcated to

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pass air outward, left and right, to underfloor ducting routed down each side of the passenger cabin. The air is then ducted upward, behind the furnishing panels, to a continuous outlet grille fitted below the hat rack.

Air is passed to the vestibules through roof level inlets, and to the toilets through gaps above and below the toilet doors.

Conditioned air for the flight deck is tapped from the left-hand air mixing duct and passed via a non-return valve into a multiple outlet duct, one branch is the distribution systems interconnection, the second branch incorporates the ground conditioning connection. The third branch, incorporating a restrictor to limit the supply flow, passes conditioned air into the flight deck through foot warmers adjacent to each set of rudder pedals, through outlets below each sidewall console, and through a diffuser outlet mounted on the centre roof which is manually regulated by an adjacent control valve.

Cold air supplies for the passenger cabin and flight deck louvre system are tapped from the cold air plenum duct and passed upward through delivery ducts to the distribution ducting that extends along both sides of the passenger cabin behind the hat racks. Flexible hoses connect the distribution ducting to a cold air louvre box fitted in each passenger service panel. The flow of cold air from the louvre box is individually controlled by manually-operated louvre control valves, fitted on the service panels at each seat position.

The right-hand distribution ducting extends forward to the flight deck, and branches into three ducts, two of the ducts pass forward to an outlet in each sidewall console; the third duct connects to a louvre outlet mounted at a central roof position.

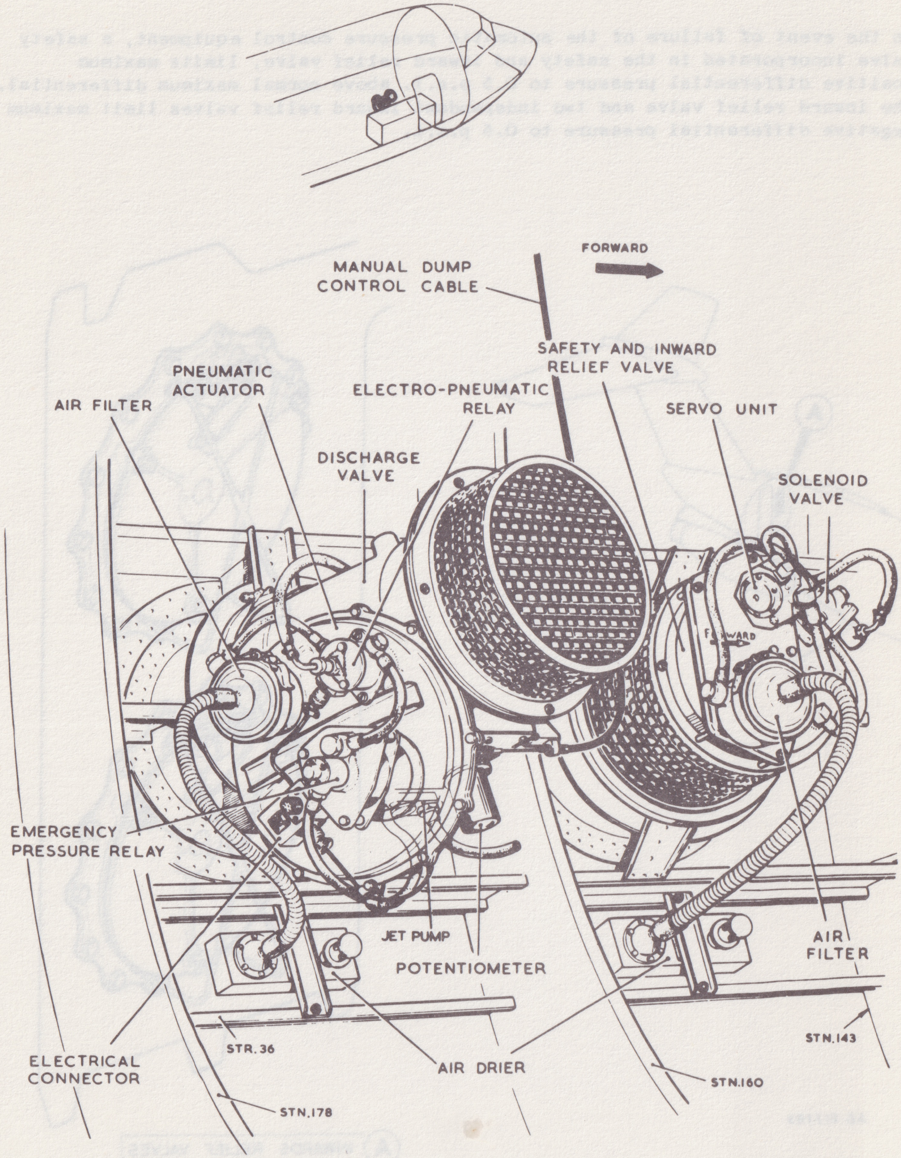
Exhaust air from the passenger cabin passes through a floor level grille, running the length of each side of the cabin, and is directed into the underfloor space.

Air from the forward vestibule and the flight deck is exhausted to the underfloor space by a fan, which first draws the air through the radio rack for cooling purposes. Extractor fans are also fitted in each toilet to pass air to the exhaust airflow. Exhaust airflow is utilized for freight hold heating, by ducting the air through tunnels formed between the fuselage frames and lagging, thus heating the sides and bottom of both freight holds.

The exhaust airflow passes around the aft freight hold, over the torque box pressure skin, then around the forward hold and through holes in the nose undercarriage bay aft bulkhead to the pressure control system discharge valve.

Pressurization is maintained at any selected value below normal maximum differential by controlling the discharge of exhaust air through the discharge valve to atmosphere.

The pressure control equipment is automatic, with provision for crew selection of cabin altitude and rate-of-change of cabin altitude. The discharge valve can be opened manually by means of a control knob in the flight deck.


FORWARD
MANUAL DUMP CONTROL CABLE
SAFETY AND INWARD RELIEF VALVE
PNEUMATIC ACTUATOR
ELECTRO-PNEUMATIC RELAY
AIR FILTER
SERVO UNIT
DISCHARGE VALVE
SOLENOID VALVE
FORWARD
EMERGENCY PRESSURE RELAY
JET PUMP
AIR FILTER
POTENTIOMETER
STN.143
STR.36
ELECTRICAL CONNECTOR
AIR DRIER
STN.160
STN.178

Discharge and Safety Valves
Figure 4

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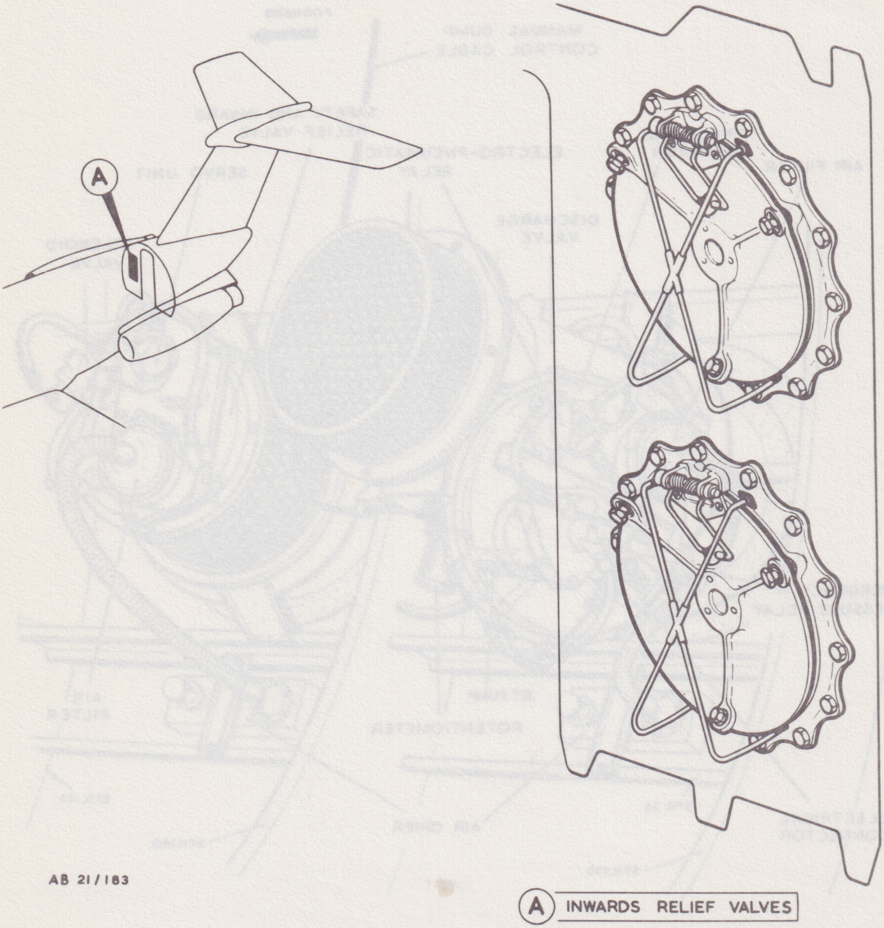
In the event of failure of the automatic pressure control equipment, a safety valve incorporated in the safety and inward relief valve, limits maximum positive differential pressure to 0.5 p.s.i. above normal maximum differential. The inward relief valve and two independant inward relief valves limit maximum negative differential pressure to 0.5 p.s.i.



Inwards Relief Valves

Figure 5

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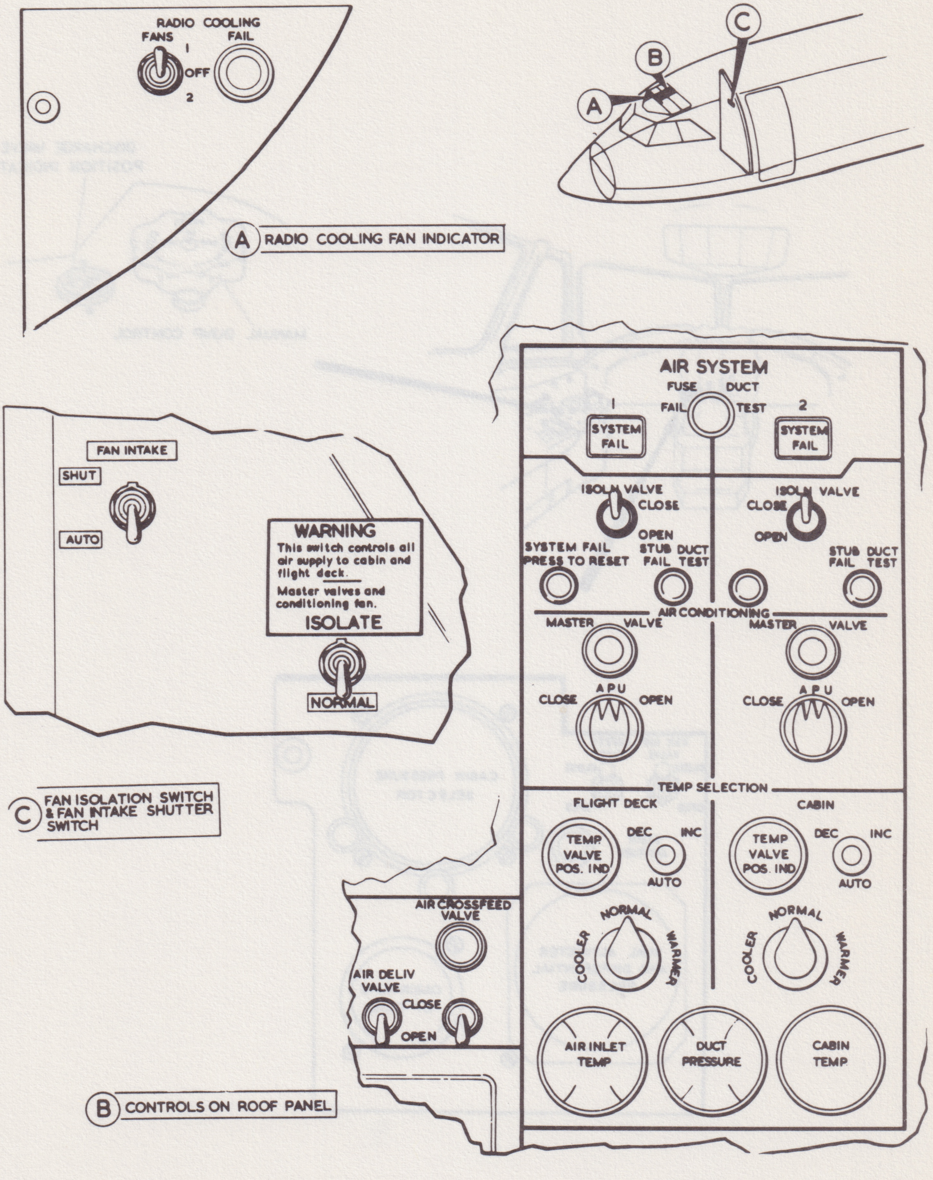
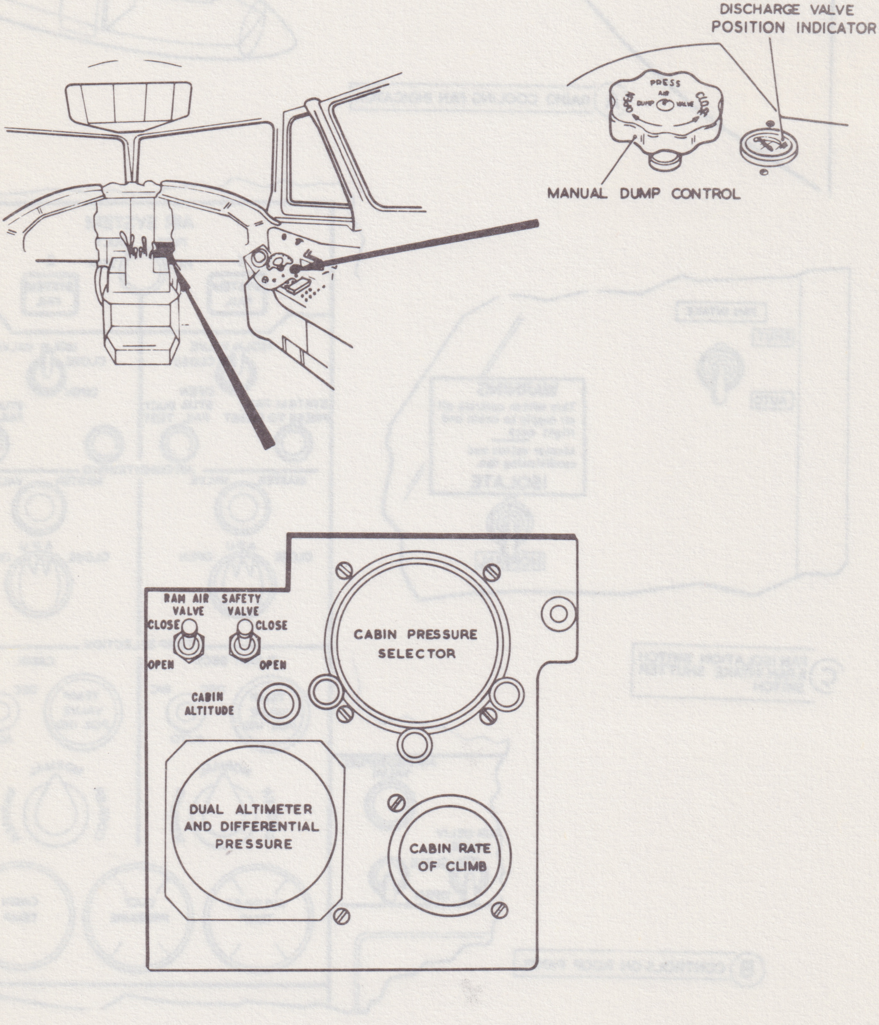

RADIO COOLING
FANS
FAIL
1
OFF
2
A
B
C
A RADIO COOLING FAN INDICATOR
FAN INTAKE
SHUT
AUTO
WARNING
This switch controls all air supply to cabin and flight deck.
Master valves and conditioning fan.
ISOLATE
NORMAL
C FAN ISOLATION SWITCH & FAN INTAKE SHUTTER SWITCH
AIR SYSTEM
FUSE
DUCT
FAIL
TEST
1
2
SYSTEM FAIL
SYSTEM FAIL
ISOLN VALVE
CLOSE
OPEN
ISOLN VALVE
CLOSE
OPEN
SYSTEM FAIL PRESS TO RESET
STUB DUCT FAIL TEST
STUB DUCT FAIL TEST
AIR CONDITIONING
MASTER
VALVE
MASTER
VALVE
CLOSE
APU
OPEN
CLOSE
APU
OPEN
TEMP SELECTION
FLIGHT DECK
CABIN
TEMP VALVE POS. IND
DEC
INC
AUTO
TEMP VALVE POS. IND
DEC
INC
AUTO
NORMAL
COOLER
WARMER
NORMAL
COOLER
WARMER
AIR CROSSFEED VALVE
AIR DELIV VALVE
CLOSE
OPEN
AIR INLET TEMP
DUCT PRESSURE
CABIN TEMP
B CONTROLS ON ROOF PANEL

BO 033

Typical Air Conditioning Controls and Indicators
Figure 6


DISCHARGE VALVE POSITION INDICATOR
PRESS
AIR
DUMP VALVE
OPEN
CLOSE
MANUAL DUMP CONTROL
RAM AIR VALVE
SAFETY VALVE
CLOSE
CLOSE
OPEN
OPEN
CABIN ALTITUDE
CABIN PRESSURE SELECTOR
DUAL ALTIMETER AND DIFFERENTIAL PRESSURE
CABIN RATE OF CLIMB

Typical Pressurization Controls and Indicators
Figure 7

AIR-SERVICING

FILTERS (Fig.101)

A. Temperature Sensor (Water Extractor) (Fig.101)

Remove panels F4-13 and 23 in the underwing fairing. Disconnect the air pipe from the special adapter taking care not to disturb the adapter on its seat. Remove the setscrews, lift off the cover and withdraw the filter element.

Insert a new filter element (Vokes-C80638-3C); refit the cover with a new O-ring seal (DOWTY-GD2005B/5); tighten the setscrews, peen the cover into one end of each screwdriver slot. Reconnect the air pipe and wirelock.

B. Air Conditioning Fan (Fig.101)

Remove panels F4-13 and 23 in the underwing fairing. Remove the section of ducting immediately aft of the fan. Remove the central nut and spring washer then remove the cap. Clean the breathers with a soft brush moistened with clean kerosine, dry with clean compressed air then refit the cap, spring washer, nut and ducting.

C. Water Extractor (Fig.101)

To gain access to the condenser element (Normalair 566123) it is necessary to remove the water extractor from the aircraft and reference must be made to the aircraft Maintenance Manual.

D. Pneumatic Actuator (Fig.101)

Remove panels F4-18 and 31 in the underwing fairing. Solenoid valve filter. Remove the air pipe, filter body and filter unit. Fit a clean or new filter (Normalair 567257), a new sealing ring (Normalair 564152/2), refit the filter body and air pipe and wirelock. Vent filter. Remove the retaining ring and filter. Fit a clean or new filter (Normalair 56611100), refit the retaining ring. Cleaning. Wash the filters with isopropyl alcohol (BS1595 or MIL-F-5566) or a similar cleaning agent.

E. Flow Control and Shut-off Valve (Fig.102)

CAUTION: THE TWO FILTER ASSEMBLIES ARE NOT INTERCHANGEABLE.

Remove panels F4-18 and 31 in the underwing fairing. Remove the air pipe from the pneumatic actuator to the metering valve. Removal and assembly of both filters is identical. Remove the plug, packing ring and spring; withdraw the filter, washers and retainer. Wash in isopropyl alcohol (BS1595 or MIL-F-5566) or a similar cleaning agent, and dry with clean compressed air. Insert the retainer and washer into the housing; fit two washers onto the outer end of the filter; insert the filter seating it centrally on the retainer. Refit the spring, packing ring and plug then wirelock. Refit the air pipe, tighten and wirelock the union nuts. Filters:- Solenoid valve, Normalair 111790-2NA; metering valve, 111790-4NA.

F. Pressure Sensing Override (Fig.102)

Remove the furnishing panels each side of the aft entrance tunnel. Clean the coalescer with a soft brush moistened with clean kerosine.

G. Shut-off Valve and

H. Pressure Reducing Valve (Fig.101)

To gain access to the filters it is necessary to remove the valves from the aircraft and reference must be made to the aircraft Maintenance Manual.

J. Air Drier (Discharge Valve) (Fig, 102)

Open access panel F1-2. Disconnect the air hose. Remove the screws, lockwashers, backing plate, outlet and gasket. Withdraw the filter and O-ring. Clean the filter (Normalair 563255) with isopropyl alcohol (BS1595 or MIL-F-5566) or similar cleaning agent. Remove tobacco stains with a 5% solution of Stergene or equivalent (MIL-D-16791E) in warm water. Renew the O-ring seal (Dowty S.P915C/18)and gasket (Normalair 563252). Insert the filter and O-ring seal, re-assemble the outlet, backing plate, lockwashers and screws. Reconnect the air hose.

K. Discharge Valve (Fig.102)

Open access panel F1-2. Disconnect the air hose; remove the safety pin, clamp ring and cover; withdraw the O-ring seal, filter cartridge and seal. Fit a new seal (Normalair 557538), a new filter cartridge (Vokes D68080, MSA CR79030 or MSA CR73927/C), and a new O-ring seal (Dowty SP901C14). Re-assemble the cover, clamp ring and safety pin. Reconnect the air hose.

Clean the grille using the cleaning agents detailed in J. above.

L. Pressure Line Water Drain and Filter (Fig.102)

Open the access panel F1-2, (or F2-1 on some later aircraft models). Two identical filters are mounted side by side, one in the line to the domestic water tank and water closets, the other in the line to the discharge valve. They are located on the nosewheel box L.H. wall (or L.H. side of the electronics bay on later aircraft). Sever the locking wire, unscrew the clamp ring and remove the filter bowl. Sever the locking wire, remove the wingnut, washer, spring, end cap and filter insert. Fit a new filter insert (Vokes C74247), refit the end cap, spring, washer, wingnut and wire lock the wingnut. Clean the filter bowl with a lint free cloth and re-assemble with a new O-ring seal (Vokes C62622/13). Wire lock the clamp ring.

M. Radio Rack (Fig.102)

Remove the filter retainers on the inboard face of the radio rack by releasing the quick-release fasteners. Discard the filters. Re-assemble with new filters (Owens-Corning Type C).

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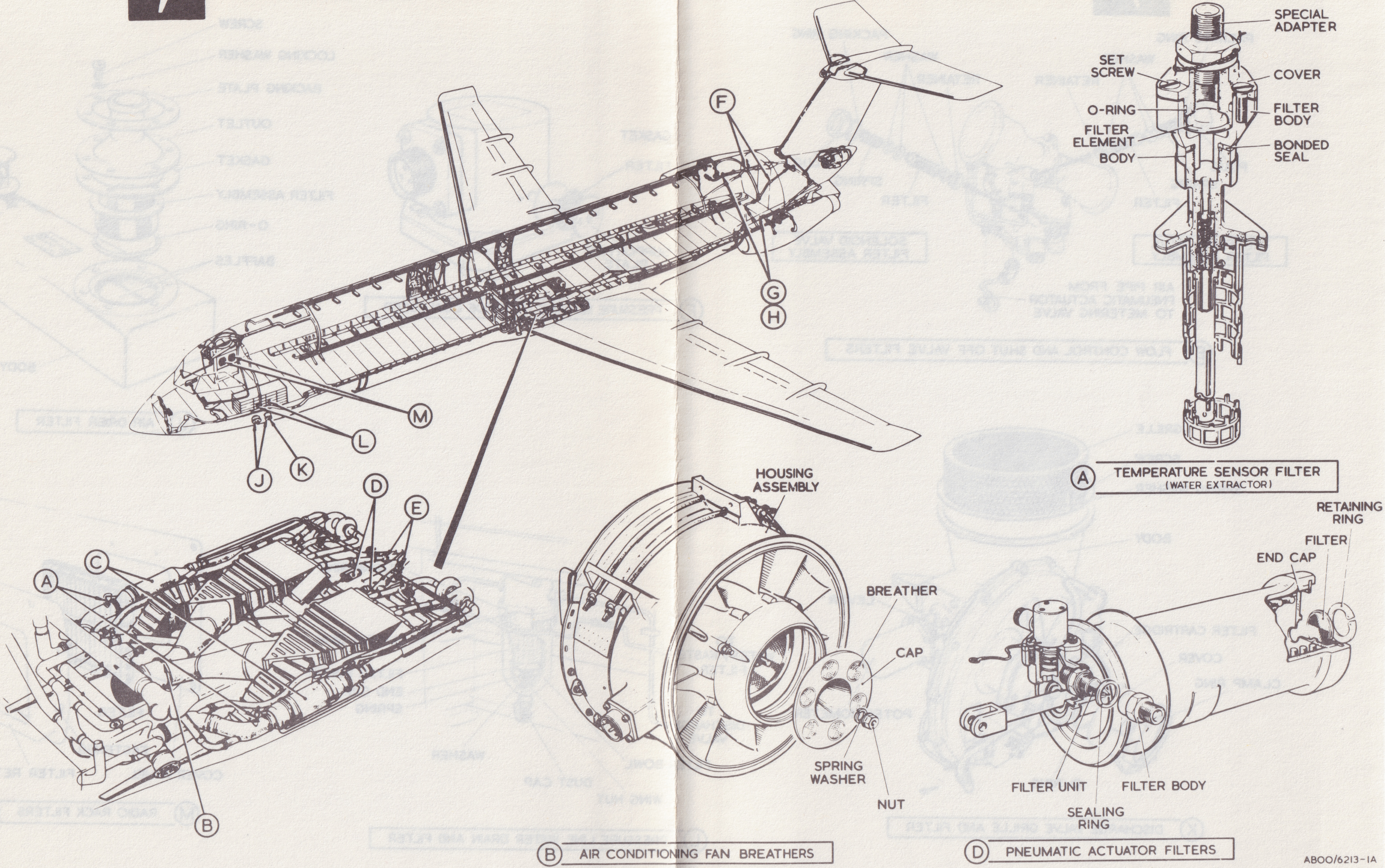
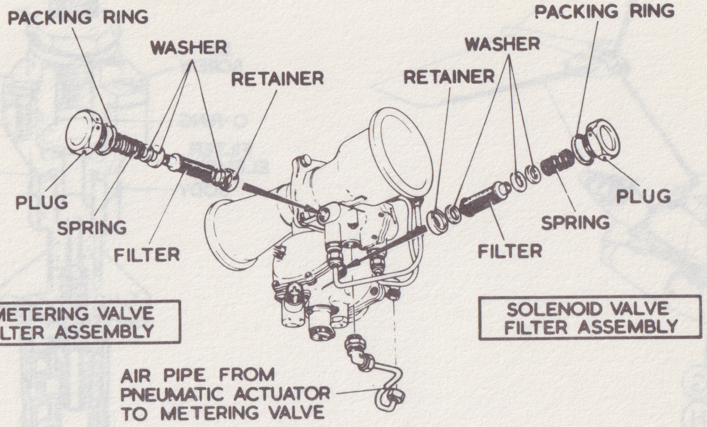
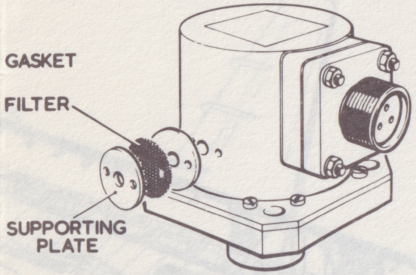

F
G
H
M
L
K
J
D
E
C
A
B
HOUSING ASSEMBLY
BREATHER
CAP
SPRING WASHER
NUT
B AIR CONDITIONING FAN BREATHERS
SPECIAL ADAPTER
SET SCREW
COVER
O-RING
FILTER BODY
FILTER ELEMENT
BONDED SEAL
BODY
A TEMPERATURE SENSOR FILTER (WATER EXTRACTOR)
RETAINING RING
FILTER
END CAP
FILTER UNIT
FILTER BODY
SEALING RING
D PNEUMATIC ACTUATOR FILTERS

AB00/6213-1A

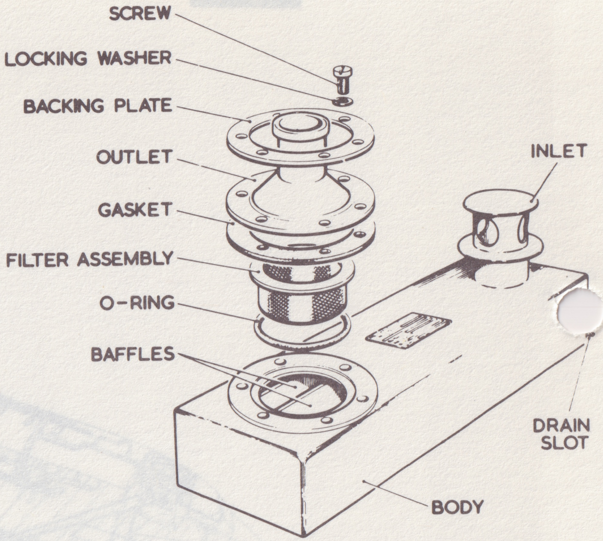
Air Filters
Figure 101
(See also Figure 102)


PACKING RING
WASHER
RETAINER
PLUG
SPRING
FILTER
METERING VALVE FILTER ASSEMBLY
PACKING RING
WASHER
RETAINER
PLUG
SPRING
FILTER
SOLENOID VALVE FILTER ASSEMBLY
AIR PIPE FROM PNEUMATIC ACTUATOR TO METERING VALVE

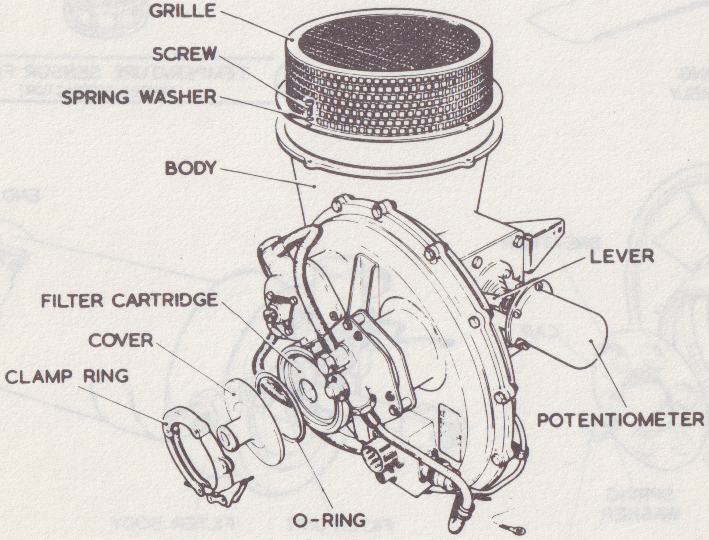
Ⓔ FLOW CONTROL AND SHUT OFF VALVE FILTERS


GASKET
FILTER
SUPPORTING PLATE

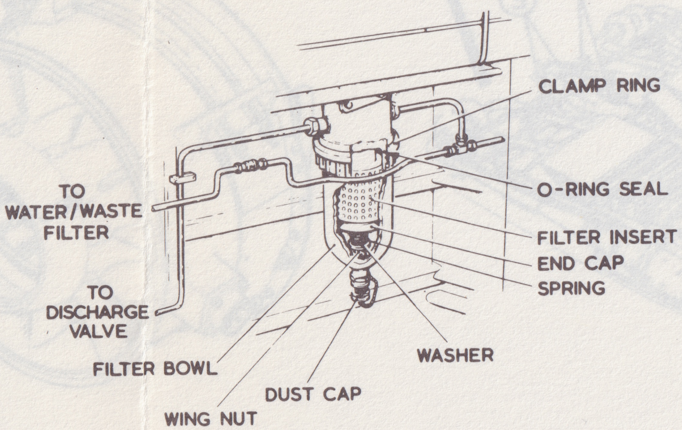
Ⓕ PRESSURE SENSING OVERRIDE COALESCER


SCREW
LOCKING WASHER
BACKING PLATE
OUTLET
GASKET
FILTER ASSEMBLY
O-RING
BAFFLES
INLET
DRAIN SLOT
BODY

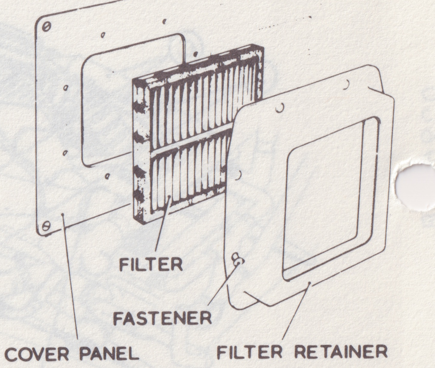
Ⓙ AIR DRIER FILTER


GRILLE
SCREW
SPRING WASHER
BODY
LEVER
FILTER CARTRIDGE
COVER
CLAMP RING
POTENTIOMETER
O-RING

Ⓚ DISCHARGE VALVE GRILLE AND FILTER


CLAMP RING
TO WATER/WASTE FILTER
O-RING SEAL
FILTER INSERT
END CAP
SPRING
TO DISCHARGE VALVE
WASHER
FILTER BOWL
DUST CAP
WING NUT

Ⓛ PRESSURE LINE WATER DRAIN AND FILTER


FILTER
FASTENER
COVER PANEL
FILTER RETAINER

Ⓜ RADIO RACK FILTERS

AB00/6213-2A

6079661

Air Filters
Figure 102
(See also Figure 101)

AUTO - PILOT

General

The auto-pilot has the normal facilities for cruise and approach flying with full self monitoring of the pitch channel to give added integrity when the aircraft is operating at the lower limits of an ILS approach.

The auto-pilot accepts navigational commands originated by the pilot, the flight director and compass systems or by the navigation receivers. It can also be controlled by manual commands of the pilot or by commands originating from various attitude sensors. The auto-pilot supplies electrical signal outputs to drive servo motors coupled into the aircraft control runs so that the control surfaces are positioned in response to auto-pilot demands. It is a fully transistorized system of modular construction and affords the following facilities:-

Yaw damping integrated with auto-pilot modes.
Automatic holding of attitude, compass heading, pre-set heading and altitude.
Variable angle capture and automatic tracking of VOR radial signals.
Variable angle approach to and automatic capture of ILS localizer beams.
Manual or automatic capture and coupling of a glide slope beam.
Automatic turn co-ordination.
Controller adjustment of pitch attitude and heading.
Automatic pitch trim.
Roll synchronisation at auto-pilot engagement.
Automatic pitch angle and bank angle limiting.
Automatic modification of auto-pilot demands in accordance with altitude and airspeed.
Automatic smoothing of VOR data and erratic VOR signals when over the VOR ground station.
System monitoring for hardover faults in all pitch and azimuth modes.

Automatic monitoring of auto-pilot operation is achieved by the constant comparison of auto-pilot demand with aircraft response information. Should a discrepancy occur between demand and response, within specified limits, automatic disengagement occurs with visible and, when fitted, audible warnings.

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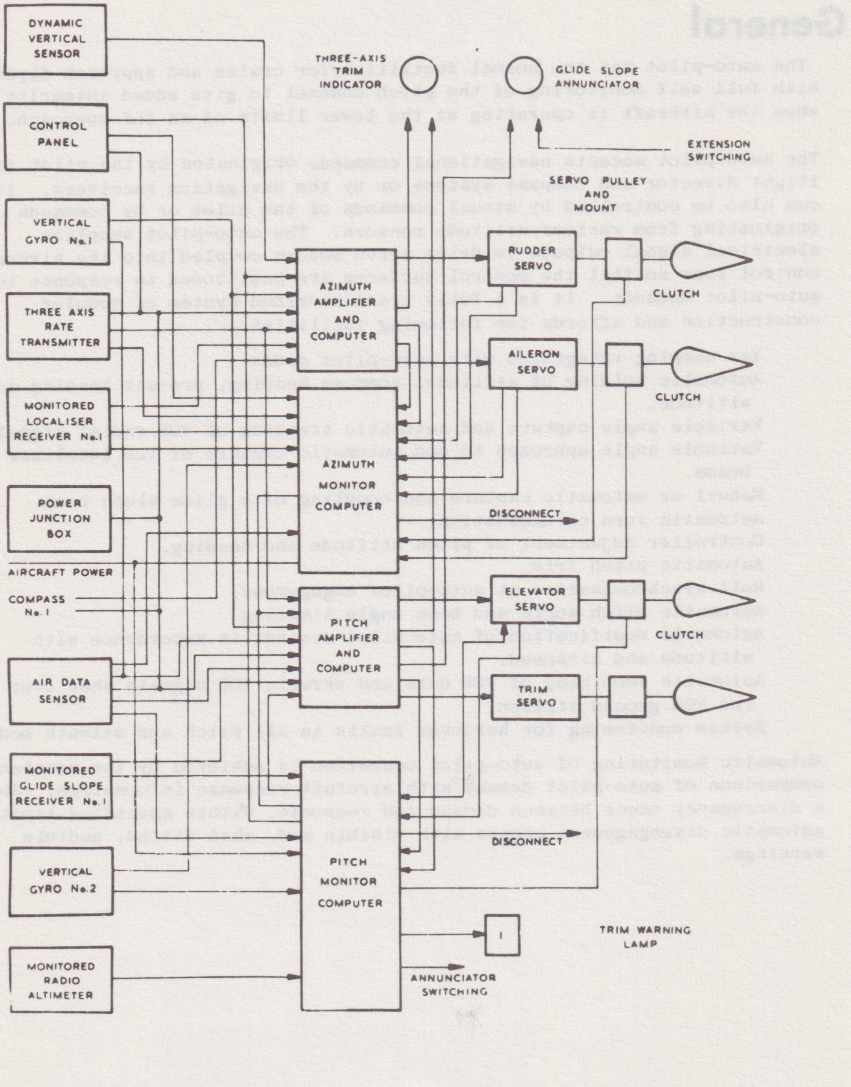
DYNAMIC VERTICAL SENSOR
CONTROL PANEL
VERTICAL GYRO No.1
THREE AXIS RATE TRANSMITTER
MONITORED LOCALISER RECEIVER No.1
POWER JUNCTION BOX
AIRCRAFT POWER
COMPASS No.1
AIR DATA SENSOR
MONITORED GLIDE SLOPE RECEIVER No.1
VERTICAL GYRO No.2
MONITORED RADIO ALTIMETER
THREE-AXIS TRIM INDICATOR
GLIDE SLOPE ANNUNCIATOR
EXTENSION SWITCHING
SERVO PULLEY AND MOUNT
AZIMUTH AMPLIFIER AND COMPUTER
AZIMUTH MONITOR COMPUTER
PITCH AMPLIFIER AND COMPUTER
PITCH MONITOR COMPUTER
RUDDER SERVO
AILERON SERVO
ELEVATOR SERVO
TRIM SERVO
CLUTCH
CLUTCH
CLUTCH
DISCONNECT
DISCONNECT
TRIM WARNING LAMP
ANNUNCIATOR SWITCHING

System Block Diagram
Figure 1

Additional safety is provided by means of interlocks all of which must be satisfied before auto-pilot engagement is possible. If any interlock, other than the mode selector switch or turn control interlocks, opens after auto-pilot engagement, the auto-pilot automatically disengages with warnings.

Automatic disengagement causes the minimum disturbance from the aircraft's flight path.

Description

Auto-pilot Controller

The controller embodies all the basic controls and switches associated with the auto-pilot and consists mainly of three switching units mounted on a panel. The following controls and switches presented on the panel from right to left are:-

(1) ALT selector switch for engaging altitude hold.
(2) AUTO-PILOT-OFF-DAMPER switch for engaging auto-pilot or separate yaw damper.
(3) DOWN-UP pitch wheel for the manual control of pitch attitude.
(4) TURN control for manually setting-in turn commands.
(5) A second pitch wheel mechanically linked to item (3).
(6) Mode selector switch with HDG (heading), MAN (manual), LOC VOR, GS AUTO (automatic glide slope capture) and GS MAN (manual glide slope capture) positions for mode engagement.

Four internally mounted lamps are used to illuminate the front panel engravings with white light for daylight operations or red light for night operation.

Pitch Amplifier and Computer

The pitch amplifier and computer contains all the electrical circuits necessary to compute and process pitch command signals to the elevator and trim commands for automatically trimming the variable incidence tailplane.

Pitch Monitor

This unit contains all the electrical circuits necessary to compare duplicate command signals from the pitch channel with signals from comparison sensors. If a difference of more than a pre-determined critical amount develops between the basic and comparison sources, the unit supplies an output to automatically disengage the auto-pilot.

Height lock (altitude hold) and pitch rate signals are limited by circuits in this monitor so that hardover faults are detected and corrected before they develop to unsafe values. However, failure of the lock or of the rate signal does not result in automatic auto-pilot disengagement.

Azimuth Amplifier and Computer

The azimuth amplifier and computer contains all the electrical circuits necessary to compute and process command signals associated with the aileron and rudder channels.

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Azimuth Monitor Blanking Tray

Bridges those circuits in which provision is made for monitoring at a future stage of auto-pilot development.

Air Data Sensor

This instrument receives inputs of pitot and static pressures and from these produces electrical outputs representing airspeed and height for use as references for auto-pilot altitude control.

Other circuits within the instrument also vary auto-pilot command signals as functions of height and airspeed.

The unit is self powered and contains a monitored pitot-static transducer which automatically disengages the auto-pilot in the event of pitot-static failure.

Vertical Gyro

Three electrically driven, self-erecting vertical gyros are used for the vertical references of the aircraft and each supplies electrical signal analogues of pitch and bank attitude for auto-pilot use. A further output is used as an 'up' demand to the elevators to compensate for loss of vertical lift during turns.

No.1 vertical gyro supplies the main vertical references to the auto-pilot and No.2 supplies identical information for comparison purposes in monitoring. No.3 vertical gyro can be used as an alternative for either No.1 or No.2 in the event of failure of either of these units.

Three-axis Rate Transmitter

This instrument contains three gyro assemblies aligned, one each, with the pitch, roll and yaw axes of the aircraft. The gyros sense angular movement of the aircraft about the axes and a synchro transmitter in each gyro assembly generates signals proportional to the rate of movement. These signals are amplified and applied to the surface servo motors to move the control surfaces in the appropriate direction to oppose the aircraft movement. The signal outputs also serve to damp excursions caused by wind gusts.

Dynamic Vertical Sensor

A viscous damping pendulum, contained in this unit, is displaced when the gravitation and acceleration forces acting upon it are unequal as in a skid or sideslip. Movement of the pendulum operates a synchro transmitter which generates a signal proportional to the difference between the forces. This signal is amplified and applied to the surface servo motor in the rudder channel thus applying rudder correction as necessary and ensuring a fully co-ordinated banked turn.

Skid or sideslip caused by asymetrical thrust due to engine failure or by cross-winds is also counteracted by the signal output from the dynamic vertical sensor.

Position Transmitter

A position transmitter is employed in the elevator channel only and provides signals representative of true elevator position, relative to the tailplane, which are used in the computation of the auto-pilot elevator demand signal.

Surface Servo

A surface servo unit is connected in each of the three control channels and is used to position the associated control surface in response to auto-pilot demands.

Each unit comprises a servo motor, a gear box, an electro-magnetic clutch, a friction clutch, a synchro transmitter and a tacho-generator. The servo motor converts the auto-pilot demand signal into an output of mechanical torque which is transmitted through the gear box and the two clutches to the control surface run. The electro-magnetic clutch is engaged only when the auto-pilot is engaged and the friction clutch enables manual override of the automatic control in the event of a jammed motor or electro-magnetic clutch. The synchro transmitter generates signals proportional to the angular movement of the servo motor shaft which are fed back to a servo amplifier in the associated amplifier and computer and used to null the demand signal. The output from the tacho-generator is proportional to the rate of rotation of the servo motor shaft and is also fed back to the servo amplifier and used as a damping term on the demand signal to prevent control surface oscillation.

Trim Servo

The trim servo unit is similar in construction to the surface servo units but contains no synchro transmitter and no tacho-generator. The torque output from the servo motor is coupled to the tail trim wheels thus enabling automatic trim adjustment of the variable incidence tailplane.

This unit is electrically connected in parallel with the elevator servo and the circuit is so arranged that when the elevator demand signal rises above a predetermined value the trim servo motor is actuated and the tailplane incidence is automatically adjusted to prevent sustained elevator loading.

The friction clutch enables instant manual override when the tail trim wheels are operated.

Power Junction Box

The normal aircraft main a.c. electrical power supplies are transformed, rectified and re-distributed, as necessary, by this unit, to provide the a.c. and d.c. power required by the units of the auto-pilot system. The junction box contains power monitoring relays which automatically disengage the auto-pilot if the power fails.

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Auto-pilot Master Switch

The aircraft a.c. and d.c. electrical power supplies to the auto-pilot are routed through the auto-pilot master switch. The switch is used to isolate all units of the auto-pilot from the electrical power source.

Three-axis Trim Indicator

The three-axis trim indicator enables visible monitoring of servo response before, and auto-pilot loads after, engagement.

In flight before auto-pilot engagement the instrument indicates, by displacement from centre of indicator bars, the magnitude and direction of any auto-pilot demands existing in any of the three control channels which is not satisfied by a servo response, i.e. a servo which is not following up control surface demands in the elevator channel and servo response in the other channels.

After auto-pilot engagement the indicator bars indicate any sustained auto-pilot demand which may exist due to an out-of-trim condition of the associated control surfaces.

The indicator is a command indicator, therefore, corrective trimming action is taken in the direction indicated by the bar, e.g. if the elevator bar shows an auto-pilot nose-up demand due to a nose-down out-of-trim condition, the aircraft must be trimmed nose-up to return the indicator bar to centre.

Glide Slope Annunciator

This is a legend display unit which provides the pilot with a visible indication of the state of the glide slope circuits. The legends are as follows:-

OFF - at all times before any glide slope mode is engaged.
ARM - on engaging GS AUTO
ENG - on engaging GS MAN or on glide slope
EXT - not used for Category I operation

Operation

General

Auto-pilot control of the rudder, aileron and elevator control channels is based on the closed servo-loop system. The basic servo-loop is similar for all three channels.

When a change of attitude and/or direction is demanded, from any source, the difference between the demand and the actual state is computed and an error (demand) signal developed which is proportional to the difference. This error signal is amplified to power level in an amplifier and computer and applied to the appropriate servo motor to position the associated control surface in the correct sense to reduce the error to zero.

The demanded control surface position is, in turn, compared with actual surface position and an error signal (position feedback) developed proportional to the difference between the two positions. This signal is taken to the amplifier and computer and used to null the demand signal. As the control surface moves to meet the demand the error signal increases in amplitude and the demand signal consequently diminishes until such time as the position feed back signal and the demand signal are of equal value. The sermo motor drive is then zero, motor movement and also control surface movement ceases.

The resulting control surface deflection causes the aircraft attitude and/or direction to change so that the error between demand and actual state is zero. The demand then no longer exists and the control surfaces return to a position demanded by the flying controls.

The velocity of control surface movement to meet demand produces a signal (rate feedback) which is also taken to the amplifier and computer and used as a damping term on the demand signal, the rate feedback signal increases with increasing rate. This serves to ensure that the control surface moves in a controlled progression, instead of in steps, and prevents control surface oscillation.

In addition, an external position transmitter actuated by elevator movement, supplies a further position feedback signal for the elevator channel which is summed with the position feedback supplied by the synchro transmitter attached to the servo motor shaft. This second signal is necessary to provide true elevator position, as that obtained from the servo motor shaft position transmitter cannot take into account any backlash of the control run or of the power control positioned after the servo motor in the control sequence.

The trim servo is connected in parallel with the elevator servo-loop and the same demand signal is used for both elevator positioning and automatic tailplane trimming. The demand signal to the trim servo is taken through a Zener diode so that the tailplane incidence is only adjusted in the event of sustained elevator loading.

The system is energized and the servo motors actuated by auto-pilot demands so long as electrical power is supplied to the system, although the servo motors torque output is not clutched to the associated control run until the auto-pilot is engaged. This is to ensure that at all times, servo motor shaft position is synchronized with auto-pilot so that on auto-pilot engagement, step demands are not applied to the control surfaces.

The three-axis trim indicator displays any auto-pilot demand existing in the system before engagement, but not satisfied because of failure of the servo to follow up.

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Automatic auto-pilot disengagement is indicated by two amber warning lights. Provision is also made for an audible warning. The lights, one each on the captain's and co-pilot's instrument panels, give a flashing indication of disengagement; the audible warning system when fitted will give a warbling tone in a loudspeaker mounted in the flight deck roof, and in the flight crew's headset telephone. The audible warning is super-imposed on any signal in the audio system at the time of auto-pilot disengagement. Both warnings are cancelled by pressing the auto-pilot cut-out switch button on either control handwheel. A short audible warning will also be given with normal (even if inadvertent) operation of either disconnect switch button. The warning lights are powered from the normal aircraft 28-volt d.c.supply through a flasher unit. If the aircraft supply fails the flasher unit is by-passed and the lamps obtain their power from an auto-pilot power junction box derived supply. Under these conditions the lights give a steady light indicating that the aircraft 28-volt d.c. supply has failed, any subsequent auto-pilot disengagement causes the lights to go out.

Modes of Operation

When the auto-pilot/damper switch is set to AUTO-PILOT engagement always takes place in the MAN mode. After engagement any other operating mode can be enegaged.

Before engaging auto-pilot radio modes the associated VHF navigation system must be switched on. Which of the two navigation systems is supplying information to the auto-pilot is determined by setting of the RADIO AND FLIGHT SYSTEM TRANSFER SWITCH. If the switch is set to NORMAL or ALL ON 1, the radio information is supplied by No.1VHF NAV system; if the switch is set to ALL ON 2, No.2 VHF NAV.system supplies the radio information. The radio interlock is energized from the VHF NAV controller through the transfer switch so that when the switch is operated from NORMAL to ALL ON 1 or vice versa, it has no effect on the auto-pilot, however, operation of the switch from NORMAL to ALL ON 2,or vica versa, interrupts the supply to the radio interlock and the auto-pilot automatically disengages. Subsequent re-engagement can be made in any desired mode. The self test facility on whichever VHF NAV controller is being used is inhibited when the auto-pilot is engaged.

MAN (Manual) Mode

In this mode, aileron, rudder, elevator and trim servo motors are clutched to their respective control runs. The auto-pilot is clutched to the compass system and the azimuth channel maintains the aircraft on the compass heading obtained at the moment of engagement. The pitch attitude obtained at the moment of engagement is maintained by the pitch channel.

If the auto-pilot is engaged during a turn, a roll-out synchronizer in the azimuth channel automatically rolls the aircraft out to a wings-level attitude, irrespective of the bank angle at the moment of engagement. The azimuth channel then maintains the aircraft on the compass heading at which the auto-pilot was engaged.

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Adjustments of pitch attitude can be made using the pitch control on the auto-pilot control panel. Turns can be made using the TURN control on the same panel. In both cases aircraft response is instinctive and the degree of bank angle or the magnitude of pitch attitude change is approximately proportional to the displacement of the appropriate control.

Altitude Hold

Altitude hold can be engaged at any time after auto-pilot engagement except after a glide slope beam capture. The mode can be engaged during an ascent or a descent. When altitude hold is engaged, pitch control from the control panel is inhibited.

Altitude hold is engaged by pushing forward the ALT switch on the auto-pilot control panel. This action clutches a synchro transmitter, in the air data sensor, to the output shaft of a barometric height capsule. The signal output from the transmitter is representative of the barometric height obtaining at the moment of altitude engagement and is the height datum to which the aircraft is controlled. Any deviation from this datum results in error signals being applied to the elevator channel servo with a resultant change in pitch attitude to maintain the aircraft on the height datum. No datum adjust facility is available for this mode.

If altitude hold is engaged at capture of a glide slope beam, the ALT switch automatically returns to the off position, thus disengaging the mode, and the aircraft is automatically pitched approximately 2 degrees nose-down.

Pre-set Heading

The pre-set heading mode enables the captain to establish any heading by operation of the heading index on his course indicator. The mode is engaged by turning the mode selector switch to HDG. If desired the heading can be pre-set by the captain before mode engagement.

The heading is established by setting the heading index to the desired heading, relative to the compass card, using the HDG control on No.1 course indicator. If the heading is set before mode engagement the aircraft is automatically turned to the new heading when the mode selector switch is set to HDG. If the heading is set after mode engagement the aircraft follows the heading index until the desired heading is obtained. Changes in heading can be made by use of the heading index at any time after mode engagement.

Once the heading is established this becomes the datum to which the aircraft is automatically controlled. Any deviation from the datum is developed into an error signal which is applied to the azimuth channel to position the ailerons and rudder in the correct sense to return the aircraft to datum.

Aircraft bank angle, during large heading changes, is confined within acceptable limits by a limiter circuit in aileron channel computing.

Operation of the TURN control whilst this mode is engaged, causes the mode selector switch to return automatically to MAN with consequent auto-pilot reversion to the manual mode.

LOC VOR Mode (VOR Operation)

Engagement of this mode enables the variable angle capture and tracking of VOR radials by coupling the auto-pilot to a navigation radio receiver and a compass system.

In this mode, the aircraft course is controlled by the captain's course indicator HDG control. The navigation receiver is tuned to the frequency of the selected VOR station and the heading of the radial along which it is desired to track is set on the captain's course indicator using the COURSE control. The mode is engaged by setting the mode selector switch to LOC VOR.

The auto-pilot initially engages in the pre-set heading mode and the aircraft is steered to the desired capture angle using No.1 course indicator HDG control. The capture angle can be changed at any time prior to capture by manipulation of the HDG control. The capture angle can be monitored by observing the angle between the course indicator heading and course indices.

The aircraft is automatically steered toward the radial as when in the pre-set heading mode, until the radial error, i.e. the difference between radial and aircraft heading, is reduced to approximately 3¼ degrees. At this point a discriminant from the navigation receiver disconnects pre-set heading and engages the LOC VOR mode; the aircraft is automatically steered to track along the radial centre line. Deviations from the radial centre line are corrected by beam error as sensed by the navigation receiver and course error as sensed by the compass system. Error signals developed from beam and course error are summed and applied to the aileron and rudder channels to maintain the aircraft on track.

Under cross-wind conditions, if the radial centre line is to be followed, a heading error must exist. This error causes the aircraft to stand-off to one side of the radial such that bank demand signals from both heading and radial error are opposite and equal, thus cancelling each other and providing cross wind control or correction.

As the aircraft approaches the VOR station, small spatial displacements cause large VOR radial error. Accordingly, the radial error signal is subjected to a large degree of smoothing to avoid excessive roll activity due to the large error signals. A greater degree of smoothing is introduced when the aircraft is over the VOR station where signals are most erratic.

After passing over the VOR station another station can be used for tracking, in order to do this the auto-pilot must be returned to the pre-set heading mode and LOC VOR engagement procedure carried out again.

If the turn control is operated whilst the auto-pilot is engaged in the LOC VOR mode, the mode selector switch automatically returns to MAN with resultant auto-pilot reversions to MAN mode.

LOC VOR Mode (LOC Operation)

Operation in this mode is similar to VOR operation except that the localizer beam defines the centre line of a runway and the controlling course indicator course index is set to the runway QDM. Tuning the navigation receiver to the localizer frequency also tunes the glide slope circuits to the associated glide slope frequency.

Glide Slope Manual and Automatic

A glide slope mode can be engaged at any altitude required by operational procedure.

If altitude hold is engaged at the moment of glide slope capture, the ALT switch returns to the off position and the aircraft is automatically pitched approximately 2 degrees nose-down to prevent initial beam overshoot.

In a glide slope mode, the aircraft is automatically maintained on the glide slope and in the centre of the beam.

Deviation above or below the beam results in beam error signal outputs from the navigation receiver. These signals are applied to the elevator channel to produce pitch attitude changes which reduce the beam error to zero. If the aircraft deviates to either left or right of the localizer beam, the difference between pre-set course, as determined by the course indicator, and actual course, as sensed by the compass system, is developed into a course error signal. This signal is applied to the azimuth channel to produce aileron demands in the correct direction to reduce the course error to zero.

The glide slope signals from the navigation receiver are passed to the pitch channel through the air data sensor. At outer marker, a potentiometer in the air data sensor is clutched to the output shaft of the static transducer such that, as the potentiometer shaft is turned, as a function of decreasing altitude, the attentuation of the glide slope signal is accordingly increased. As the electrical range of the potentiometer is the equivalent of 1,000 feet the aircraft altitude is linearly reduced through a descent of 1,000 feet. After this controlled descent the middle marker is normally overflown and the glide slope signal gain is switched to a fixed value to maintain optimum glide slope performance.

During a descent down a glide slope the auto-pilot pitch control wheels are inhibited and operation of the turn control causes the mode selector switch to automatically return to MAN with auto-pilot reversion to the MAN mode.

Two modes of glide slope capture and operation are available, glide slope manual (GS MAN) normally used for a Cat.I. approach or glide slope automatic (GS AUTO), and these are described below.

1. GS MAN

This mode is only normally used when the aircraft has been flown almost onto the glide slope and time does not permit an automatic capture.

In a Cat.I approach, the captain monitors the glide slope deviation bar in his flight director indicator of course indicator and when the bar becomes centrally disposed, indicating zero deviation, the mode selector switch is set to GS MAN and the glide slope annunciator shows ENG. The auto-pilot is then coupled to the glide slope beam and the aircraft is automatically controlled down the glide slope to a Category I break-off height.

2. GS AUTO

This mode can be engaged at any time when a large beam error exists. The mode is engaged by setting the mode selector switch to GS AUTO; ARM then appears on the glide slope annunciator.

The auto-pilot initially operates in the localizer mode until the aircraft is about to intercept the glide slope beam at approximately 1/40 degree beam error. At this point the system automatically captures the beam and directs the aircraft down the beam path. At beam capture the glide slope annunciators show ENG.

At a point nominally 400 feet below outer marker height, glide slope operation enters the extension phase and the glide slope annunciators show EXT. This phase introduces close tolerance monitoring of the glide slope performance to give much greater integrity to auto-pilot control at the lower limits of the glide slope path.

Provision is made for radio altimeter interlocks to be introduced into the auto-pilot interlock system at 140 feet, radio altimeter height on the glide slope. From this point the radio altimeter will provide auto-pilot height references and enables a finer degree of automatic control at heights below Category I limits. Glide slope monitoring is disconnected to avoid nuisance disengagements and any subsequent failure of the radio altimeter automatically disengages the auto-pilot.

From the 140 feet, radio altimeter height, the circuits are so arranged that deviation below the glide slope is immediately corrected, but the rate of attitude change resulting from a nose-down demand, because of deviation above the glide slope, is much slower.

Auto-pilot Yaw Damper

The yaw damping facility is engaged by setting the auto-pilot/damper switch to DAMPER. This energizes the auto-pilot rudder channel only giving automatic stabilization in the yaw axis whilst attitude and direction remain under manual control.

COMMUNICATIONS

General

Dual VHF communication systems are installed in the aircraft, providing single-channel simplex radio-telephonic communication. An HF communications system, providing for both SSB and AM modes of operation, is installed. Both systems are remotely operated from control units mounted within easy reach of the flight crew. Loudspeaker monitoring of received signals is included in the audio system.

A public address system is fitted, to enable the flight and cabin crew to make announcements to the passengers, and provision is made for the installation of a tape reproducer. A service interphone system provides telephone communication between the flight and cabin crews, and between members of the ground crew when the aircraft is being serviced.

An audio integrating system permits simultaneous, or separate, monitoring of a number of radio communication and navigation services, and includes an inter-communication service between members of the flight crew.

Static dischargers are fitted at the wing tips and on the tail unit, to discharge any static electricity formed on the aircraft.

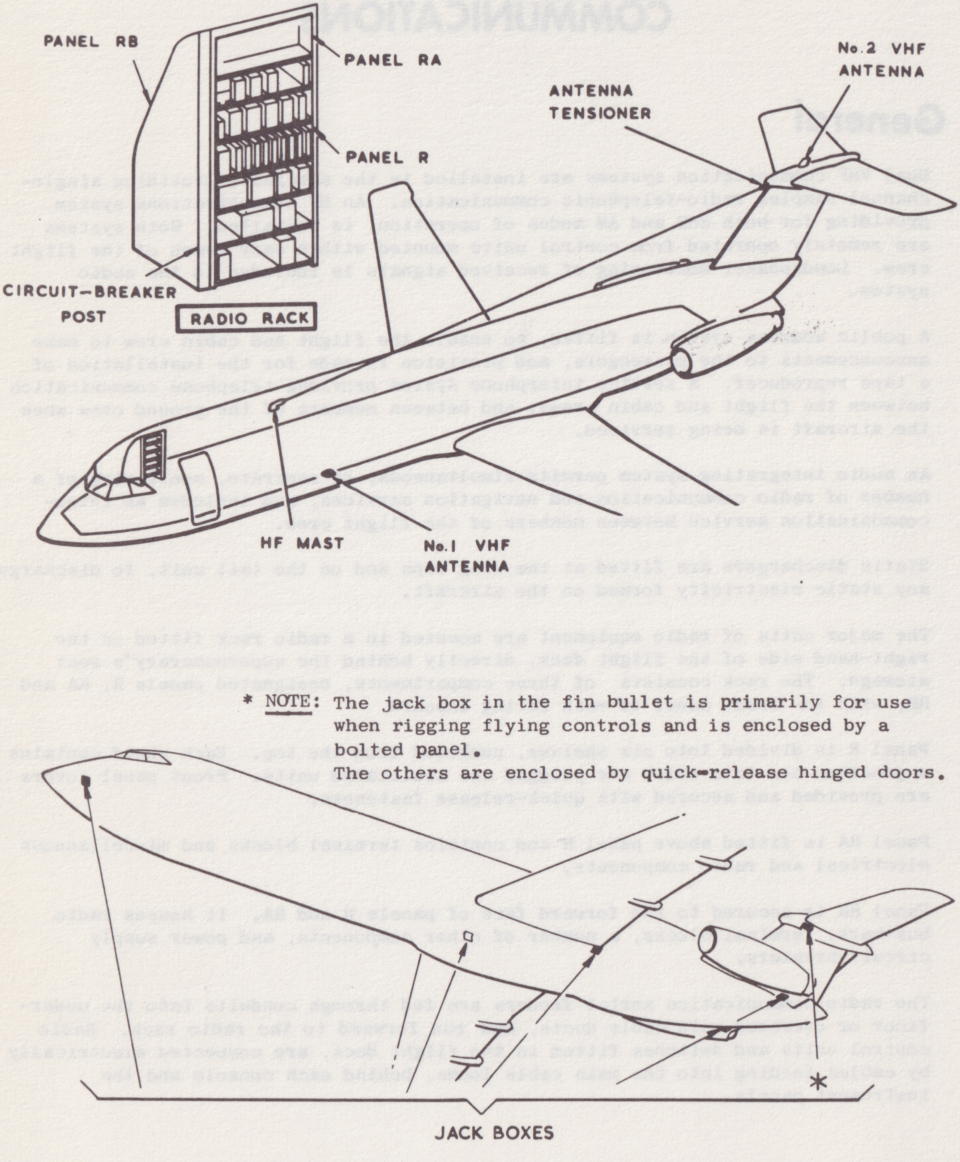
The major units of radio equipment are mounted in a radio rack fitted on the right-hand side of the flight deck, directly behind the supernumerary's seat stowage. The rack consists of three compartments, designated panels R, RA and RB, with the front panel of each facing inboard.

Panel R is divided into six shelves, numbered from the top. Each shelf contains a junction box into which are plugged the assiciated units. Front panel covers are provided and secured with quick-release fasteners.

Panel RA is fitted above panel R and contains terminal blocks and miscellaneous electrical and radio components.

Panel RB is secured to the forward face of panels R and RA. It houses radio bus-bars, terminal blocks, a number of other components, and power supply circuit-breakers.

The radio communication aerial feeders are fed through conduits into the under-floor or overhead main cable ducts, and run forward to the radio rack. Radio control units and switches fitted in the flight deck, are connected electrically by cables feeding into the main cable looms, behind each console and the instrument panels.


PANEL RB
PANEL RA
PANEL R
CIRCUIT-BREAKER POST
RADIO RACK
No.2 VHF ANTENNA
ANTENNA TENSIONER
HF MAST
No.1 VHF ANTENNA
*
JACK BOXES

* NOTE: The jack box in the fin bullet is primarily for use when rigging flying controls and is enclosed by a bolted panel.
The others are enclosed by quick-release hinged doors.

Location of Components
Figure 1

B07-859

DOORS AND HATCHES

General

The aircraft has externally a forward passenger door, a ventral door with built-in stairs, a galley service door, four overwing emergency exit hatches, two freight hold doors an electrics bay access door and an electronics (radio) bay access door.

On some Models, retractable airsteps are installed at the forward passenger entrance.

A door in the cabin rear pressure bulkhead communicates with the ventral stairway.

Perforated door seals are fitted on the forward passenger door, galley service door, rear pressure bulkhead door and both freight doors. The perforations allow air from the cabin to enter, thus inflating the seals when the cabin is pressurized.

Non-inflatable seals are fitted on the emergency exit hatches and ventral door.

An electrical warning system gives indication on the flight deck when a pressure door is unlocked. Mechanical indication is provided in each door and is visible when that particular door is locked.

FORWARD PASSENGER DOOR

This door opens outward and forward in a parallel direction to the fuselage. It has a series of load-carrying lugs on its vertical side members which engage behind similar lugs on the door frame when closed.

The door is opened by a handle in either side, the outer handle being recessed. Downward operation of the handle lifts the door approximately two inches and allows the lugs on the door to clear those on the frame, thereby allowing the door to be pushed or pulled outward. A safety latch in the lifting mechanism prevents the door lifting in response to negative 'g' during unpressurized flight. The latch is fitted with a black-and-white-striped indicator which is visible when the door is locked.

Initial lifting of the door operates a micro-switch to give a FRONT PASS door unlocked warning on the flight deck. Initial opening of the door outward engages the door uplatch to retain it in the lifted position. When fully open, the door is retained by an arm-mounted latch/hook in engagement with a pin on the inner face. The pin is withdrawn by clock-wise rotation of a hook release lever, adjacent to the inner handle, when the door is closed.

A green dual BUTT/HOOK indicator, on the door inner panel, operates in conjunction with the door warning system. Both BUTT and HOOK captions are lit when the door is fully closed and the safety latch engaged.

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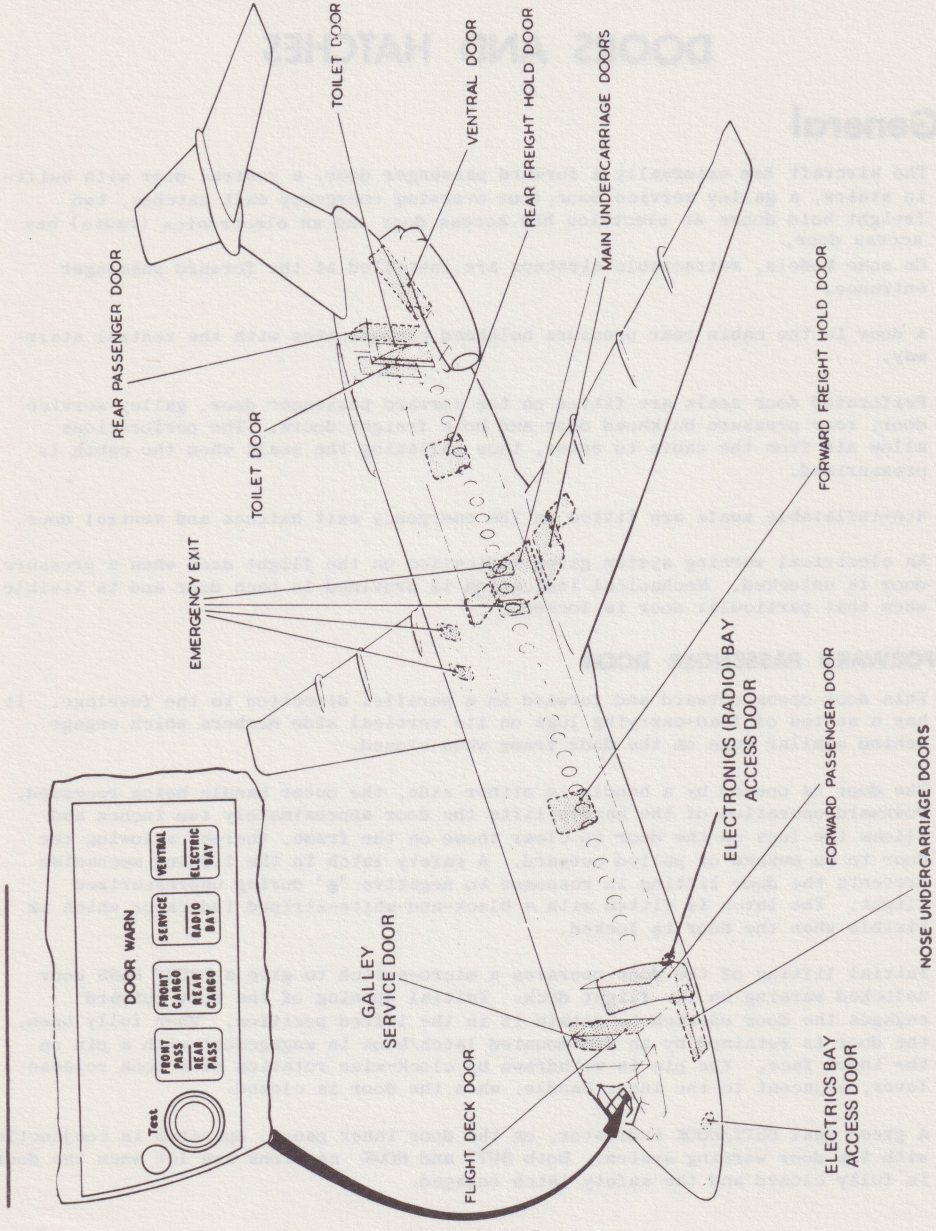
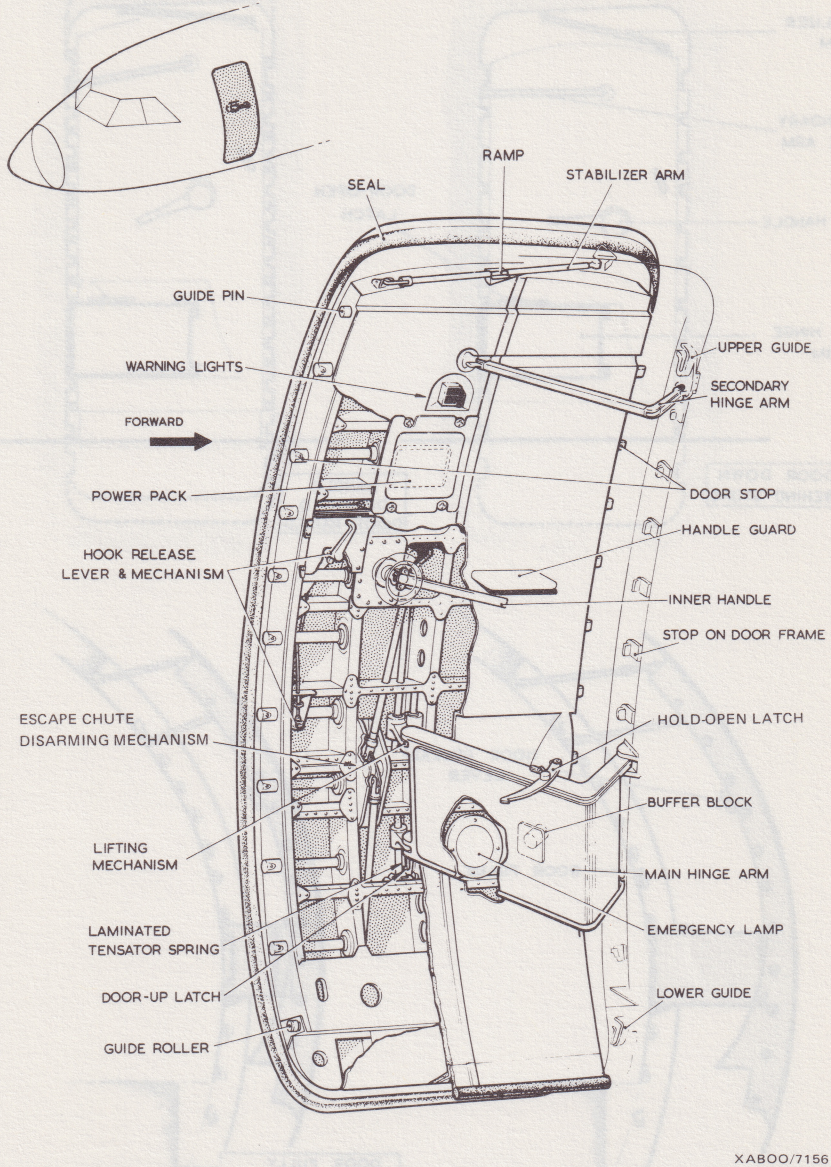
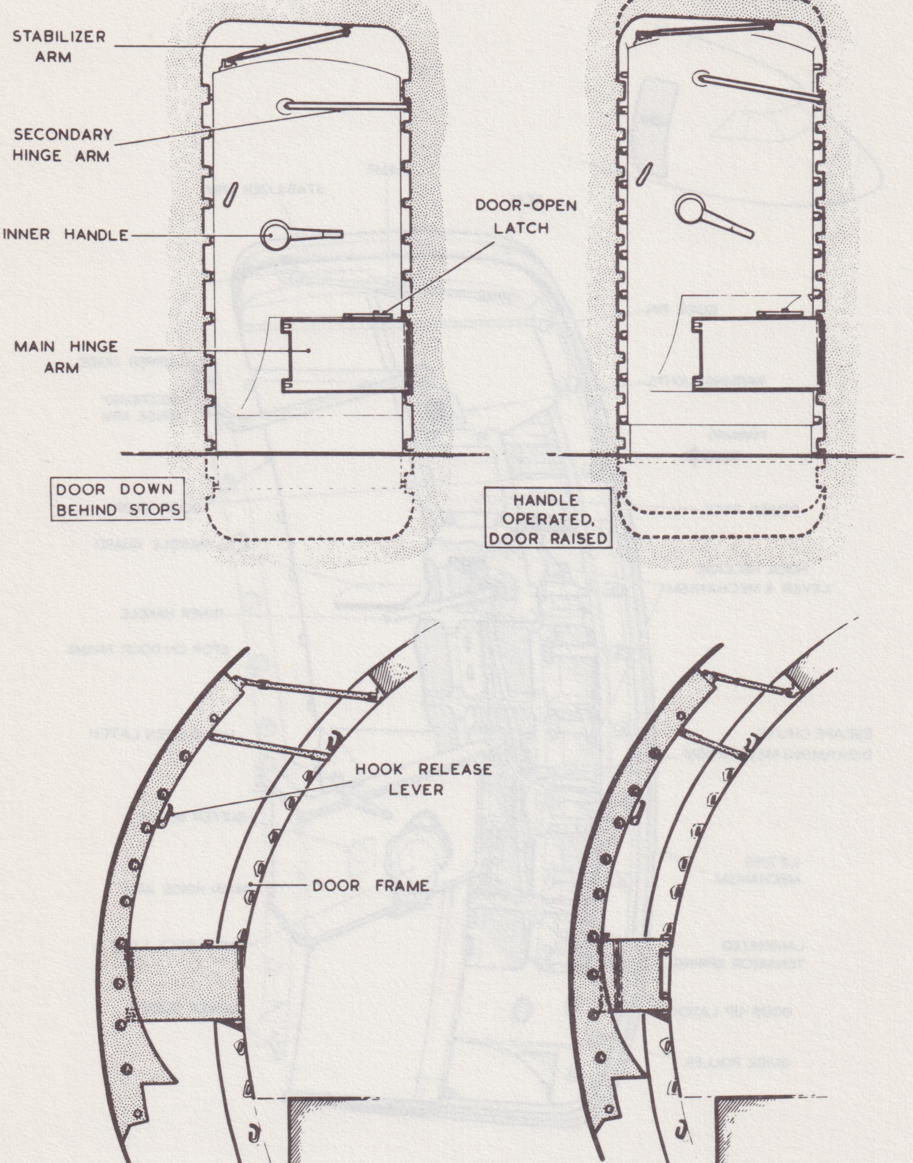

REAR PASSENGER DOOR
TOILET DOOR
VENTRAL DOOR
REAR FREIGHT HOLD DOOR
MAIN UNDERCARRIAGE DOORS
FORWARD FREIGHT HOLD DOOR
TOILET DOOR
EMERGENCY EXIT
ELECTRONICS (RADIO) BAY ACCESS DOOR
FORWARD PASSENGER DOOR
NOSE UNDERCARRIAGE DOORS
GALLEY SERVICE DOOR
FLIGHT DECK DOOR
ELECTRICS BAY ACCESS DOOR
DOOR WARN
Test
FRONT PASS
REAR PASS
FRONT CARGO
REAR CARGO
SERVICE
RADIO BAY
VENTRAL
ELECTRIC BAY

General Arrangement of Doors and Hatches
Figure 1


RAMP
SEAL
STABILIZER ARM
GUIDE PIN
UPPER GUIDE
WARNING LIGHTS
SECONDARY HINGE ARM
FORWARD
POWER PACK
DOOR STOP
HANDLE GUARD
HOOK RELEASE LEVER & MECHANISM
INNER HANDLE
STOP ON DOOR FRAME
ESCAPE CHUTE DISARMING MECHANISM
HOLD-OPEN LATCH
BUFFER BLOCK
LIFTING MECHANISM
MAIN HINGE ARM
LAMINATED TENSATOR SPRING
EMERGENCY LAMP
DOOR-UP LATCH
LOWER GUIDE
GUIDE ROLLER
XABOO/7156

Passenger/Crew Door
Figure 2


STABILIZER ARM
SECONDARY HINGE ARM
INNER HANDLE
DOOR-OPEN LATCH
MAIN HINGE ARM
DOOR DOWN BEHIND STOPS
HANDLE OPERATED, DOOR RAISED
HOOK RELEASE LEVER
DOOR FRAME
DOOR HALF OPEN
DOOR FULLY OPEN AND LATCHED
AB52/203

Passenger/Crew Door Operation
Figure 3

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VENTRAL DOOR

The hydraulic power to raise the door is normally supplied by the a.c. or the engine driven pump from No.2 system. A third source available when the other systems are not functioning is from a d.c. pump. Lowering is by free - fall movement against hydraulic damping.

The door is controlled from inside the aircraft by a three-position selector handle (and, on some aircraft, a sprung-OFF switch) on the left side immediately aft of the rear pressure bulkhead. When this handle is pulled inward and turned to DOOR UP (and the switch selected to ON) the hydraulic jack raises the door. On initial movement the hand-rail hinges in the centre and the stanchion moves rearward to lie parallel with the door.

Movement of the stanchion rotates a bogie gear, and the bogie folds and retracts inward to lie on the lower stairs. Three stops on each side of the door limit the upward travel. The door is held up by rollers at the rear end engaging in uplock hooks which lock automatically. When released, the handle is sprung to neutral position by the action of a spring. This isolates the hydraulic system and a second spring stows the handle.

When the internal handle is pulled inward and turned to DOOR DOWN, the uplock is released mechanically and the door free-falls by its own weight, the rate of descent being controlled by a restrictor on a control valve. When released the handle returns to its neutral position.

From outside the aircraft, the door is opened from a handle located in a recess on the left of the stairway. Pulling the handle mechanically releases the uplock and permits the door to free-fall. On some aircraft the door may be closed from outside the aircraft by setting the internal selector handle to DOOR UP, ensuring that the external handle is fully stowed and selecting ON at a spring-OFF switch adjacent to the external handle.

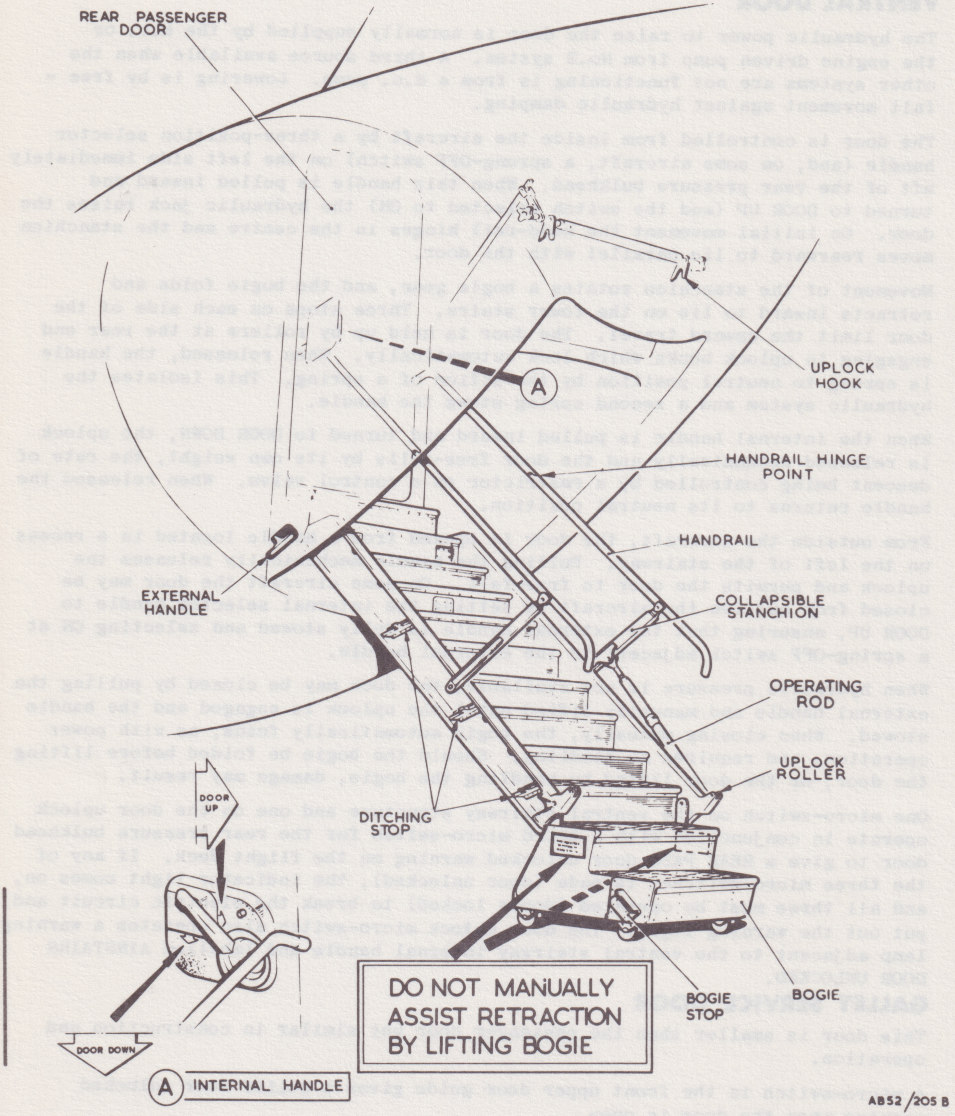
When hydraulic pressure is not available, the door may be closed by pulling the external handle and manually lifted until the uplock is engaged and the handle stowed. When closing manually, the bogie automatically folds, as with power operation, and requires no handling. Should the bogie be folded before lifting the door, or the door lifted by handling the bogie, damage may result.

One micro-switch on the ventral stairway structure and one on the door uplock operate in conjunction with a third micro-switch for the rear pressure bulkhead door to give a REAR PASS door unlocked warning on the flight deck. If any of the three micro-switches is made (door unlocked), the indicator light comes on, and all three must be operated (doors locked) to break the electric circuit and put out the warning light. The door uplock micro-switch also operates a warning lamp adjacent to the ventral stairway internal handle and labelled AIRSTAIRS DOOR UNLOCKED.

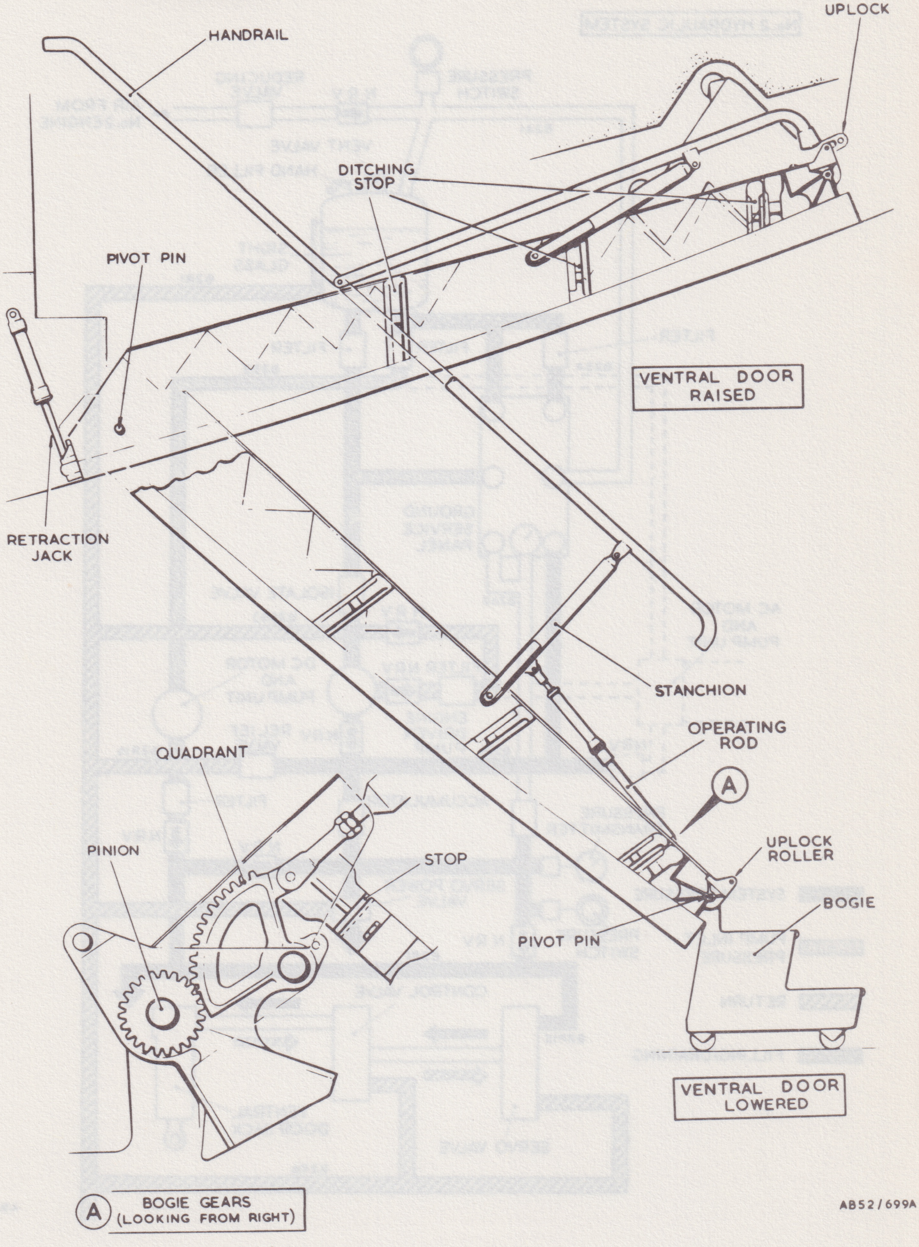
GALLEY SERVICE DOOR

This door is smaller than the passenger door but similar in construction and operation.

A micro-switch in the front upper door guide gives a GALLEY door unlocked warning when the door is open.

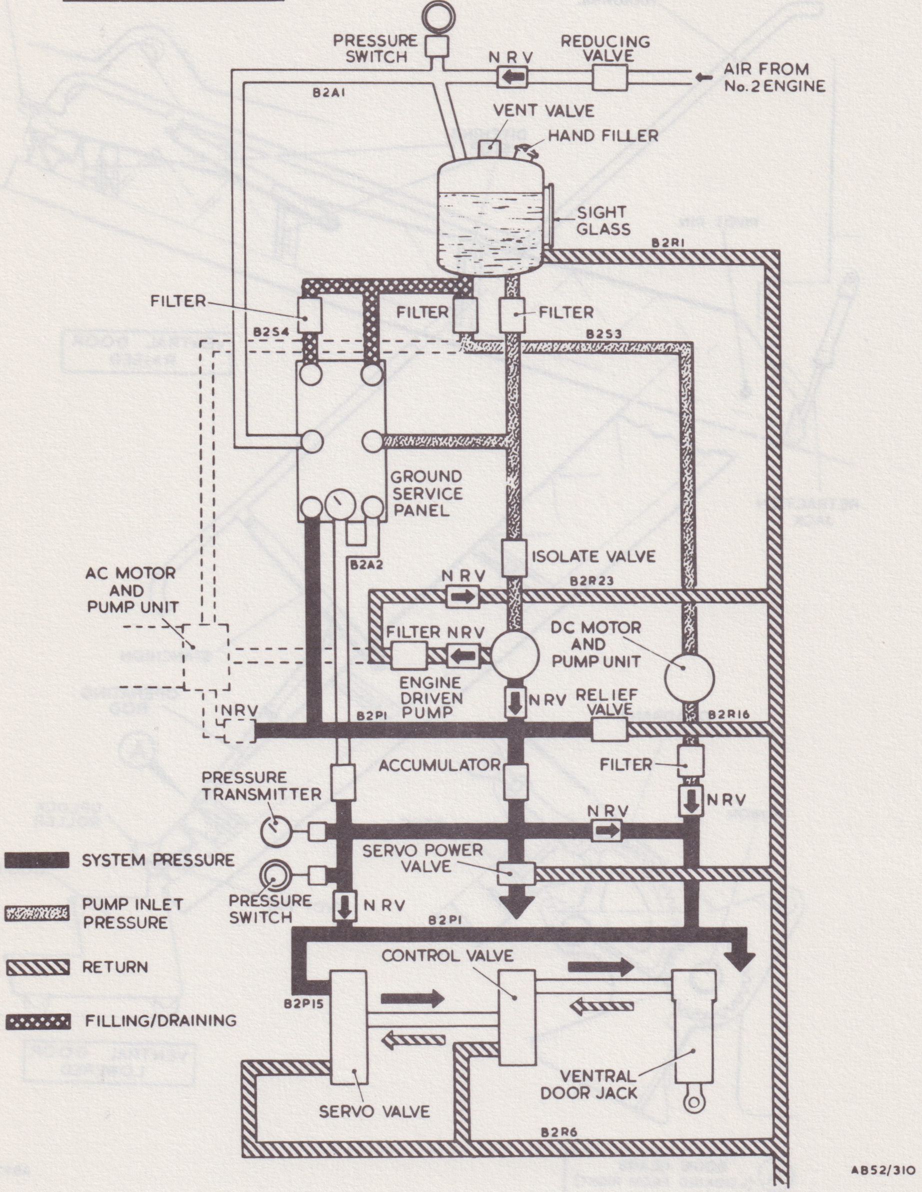

REAR PASSENGER DOOR
UPLOCK HOOK
A
HANDRAIL HINGE POINT
HANDRAIL
EXTERNAL HANDLE
COLLAPSIBLE STANCHION
OPERATING ROD
DOOR UP
UPLOCK ROLLER
DITCHING STOP
DO NOT MANUALLY ASSIST RETRACTION BY LIFTING BOGIE
BOGIE STOP
BOGIE
DOOR DOWN
A INTERNAL HANDLE
AB52/205 B

Ventral Door
Figure 4


UPLOCK
HANDRAIL
DITCHING STOP
PIVOT PIN
VENTRAL DOOR RAISED
RETRACTION JACK
STANCHION
OPERATING ROD
QUADRANT
A
UPLOCK ROLLER
PINION
STOP
BOGIE
PIVOT PIN
VENTRAL DOOR LOWERED
A BOGIE GEARS (LOOKING FROM RIGHT)
AB52/699A

Ventral Door Operation
Figure 5

No. 2 HYDRAULIC SYSTEM


PRESSURE SWITCH
N R V
REDUCING VALVE
AIR FROM No. 2 ENGINE
B2A1
VENT VALVE
HAND FILLER
SIGHT GLASS
B2R1
FILTER
FILTER
FILTER
B2S4
B2S3
GROUND SERVICE PANEL
B2A2
AC MOTOR AND PUMP UNIT
ISOLATE VALVE
N R V
B2R23
FILTER NRV
DC MOTOR AND PUMP UNIT
ENGINE DRIVEN PUMP
NRV
NRV
RELIEF VALVE
B2PI
B2R16
ACCUMULATOR
FILTER
PRESSURE TRANSMITTER
NRV
N R V
SERVO POWER VALVE
PRESSURE SWITCH
NRV
B2PI
CONTROL VALVE
B2P15
SERVO VALVE
VENTRAL DOOR JACK
B2R6
AB52/310
SYSTEM PRESSURE
PUMP INLET PRESSURE
RETURN
FILLING/DRAINING

Ventral Door Hydraulic System Schematic
Figure 6

FORWARD AIRSTEPS

The airsteps, which operate hydraulically, are housed beneath the forward vestibule floor and retained in the stowed position by a spring-catch. The motive hydraulic power and the catch are controlled by a manual selecter lever which has three positions; RAISE, neutral and LOWER. The lever is mounted within a recessed compartment in the bulkhead forward of the passenger entrance door.

To operate the airsteps, the lever is moved to the desired position and held until the airsteps complete the selected operation. When released, the lever automatically returns to the neutral position.

Hydraulic power is supplied from No.2 system, and normally generated by either the a.c. pump or engine driven pump. An alternative source of power is the d.c. pump, energized by a micro-switch when the selector lever is moved to the RAISE or LOWER positions. The d.c. pump is automatically isolated when normal sources of generation are available.

The airsteps are supported when moving horizontally by rollers fitted to the doorway structure; these also act as a fulcrum upon which the airsteps are raised or lowered.

In the 'RAISE' sequence the airsteps are lifted to the horizontal position by a lifting jack. Simultaneously, rollers fitted at the head of the steps and to the top stanchion of each handrail, enter tracks in the stowage compartment, causing the handrails to fold flat. A mechanical linkage, actuated by the folding movement of the handrails, telescopes the bottom three steps, thus reducing the airsteps' length to that of the stowage compartment.

When the airsteps reach the horizontal position, a pinion driven by a hydraulic motor engages with a rack on the steps underside, and propels the steps into the stowage housing until locked by the spring-catch. The passenger door is now unobstructed, and can be closed and locked.

In the 'LOWER' sequence, with the passenger door fully open, the spring-catch is released and power is directed to the reverse side of the hydraulic motor, driving the airsteps out to the horizontal position. The airsteps fall under their own weight, the rate of fall being controlled by a restrictor in the lifting jack return line; at the same time the handrails are erected and the lower three steps extended.

Rollers are fitted to the lower end of the airsteps to accommodate different floor heights above ground level.

OVERWING EXIT HATCHES

The hatches are opposite each other and give access on to the upper surface of the wings. Each is retained in position by spigots at the base and release mechanism at the top.

From inside the aircraft, the release mechanism handle is pulled and the hatch moved inward and lifted to free the spigots.

From outside the aircraft, a push-button is pressed, the two hand-hole covers torn off and the hatch moved inward and lifted for removal.

The DV windows, forward passenger door and galley service door are also classified as emergency exits.

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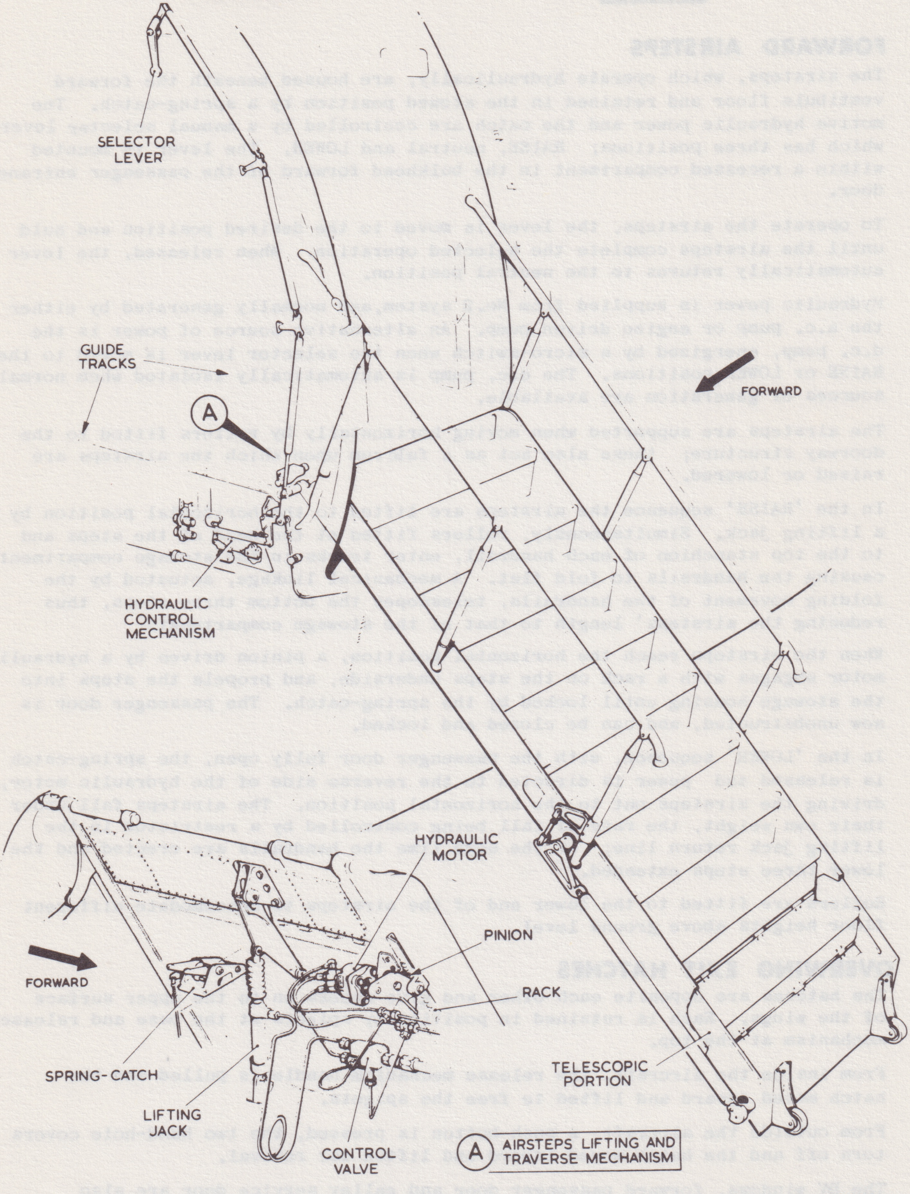
SELECTOR LEVER
GUIDE TRACKS
A
FORWARD
HYDRAULIC CONTROL MECHANISM
HYDRAULIC MOTOR
PINION
FORWARD
RACK
SPRING-CATCH
TELESCOPIC PORTION
LIFTING JACK
CONTROL VALVE
A AIRSTEPS LIFTING AND TRAVERSE MECHANISM
XABOO/4966

Forward Airsteps
Figure 7

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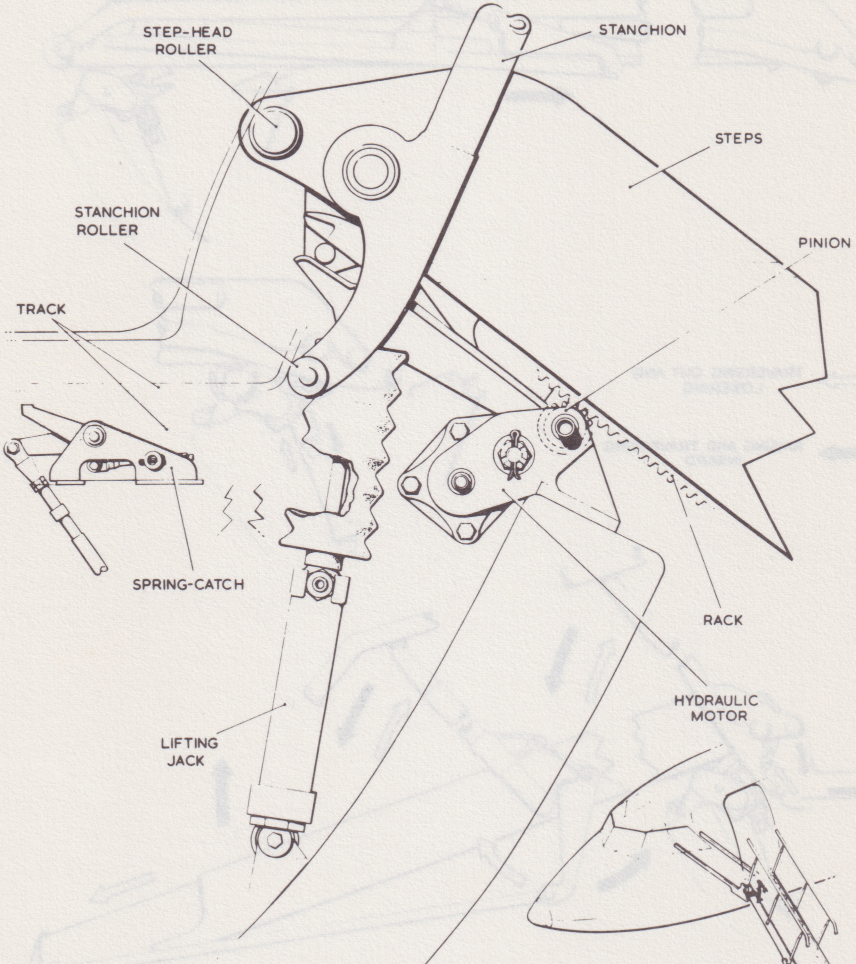
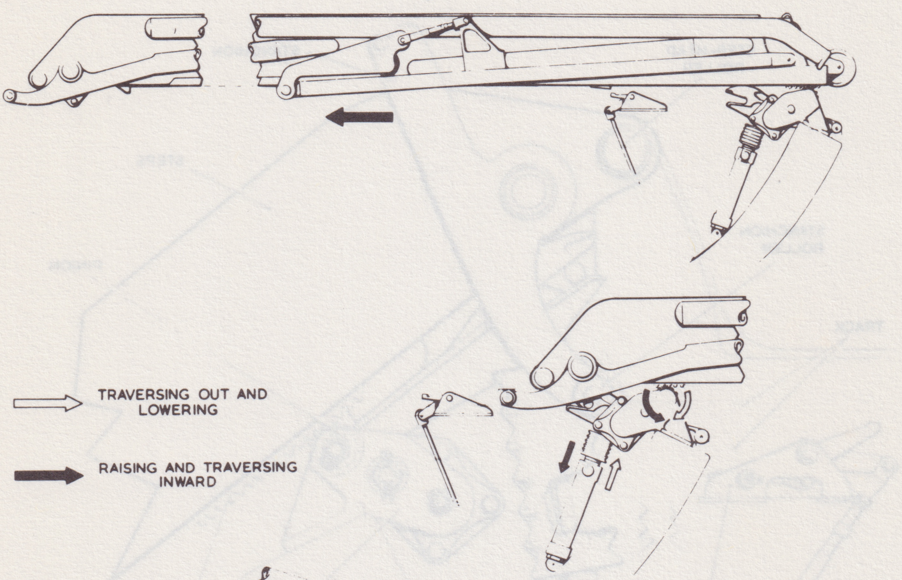

STEP-HEAD ROLLER
STANCHION
STEPS
STANCHION ROLLER
PINION
TRACK
SPRING-CATCH
RACK
HYDRAULIC MOTOR
LIFTING JACK
XABOO/4967-1

Forward Airsteps Operation (1)
Figure 8


TRAVERSING OUT AND LOWERING
RAISING AND TRAVERSING INWARD

XABOO/4967-2

Forward Airsteps Operation (2)
Figure 9

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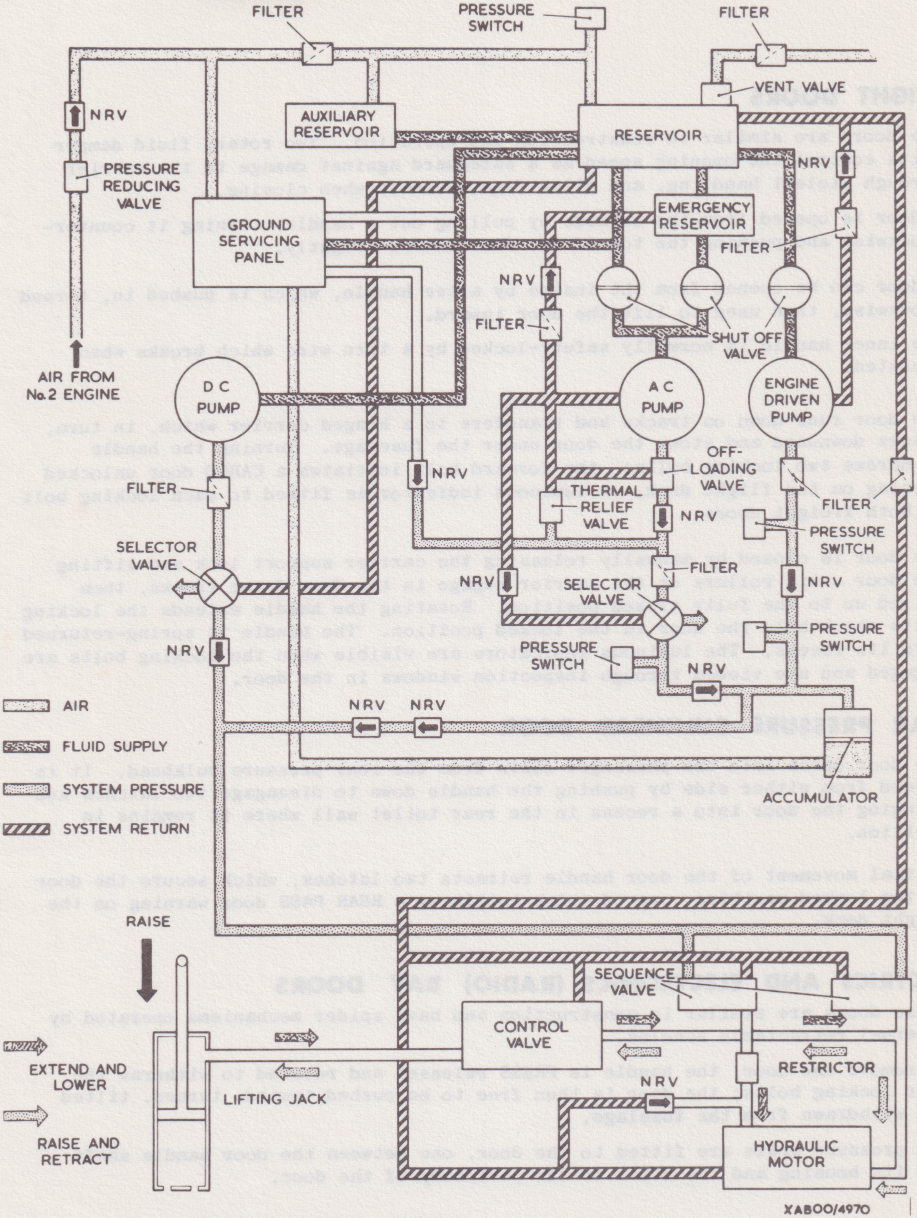
FILTER
PRESSURE SWITCH
FILTER
VENT VALVE
NRV
AUXILIARY RESERVOIR
RESERVOIR
NRV
PRESSURE REDUCING VALVE
EMERGENCY RESERVOIR
GROUND SERVICING PANEL
FILTER
NRV
FILTER
SHUT OFF VALVE
AIR FROM No.2 ENGINE
D C PUMP
A C PUMP
ENGINE DRIVEN PUMP
NRV
OFF-LOADING VALVE
FILTER
THERMAL RELIEF VALVE
NRV
FILTER
PRESSURE SWITCH
SELECTOR VALVE
NRV
FILTER
SELECTOR VALVE
NRV
PRESSURE SWITCH
NRV
PRESSURE SWITCH
NRV
NRV
NRV
ACCUMULATOR
AIR
FLUID SUPPLY
SYSTEM PRESSURE
SYSTEM RETURN
RAISE
SEQUENCE VALVE
CONTROL VALVE
EXTEND AND LOWER
LIFTING JACK
RESTRICTOR
NRV
RAISE AND RETRACT
HYDRAULIC MOTOR
XABOO/4970

Forward Airsteps Hydraulic System Schematic
Figure 10

FREIGHT DOORS

The doors are similar in construction and operation. Two rotary fluid damper units control the opening speed as a safeguard against damage to the carrier through violent handling, and allow free movement when closing.

A door is opened from the outside by pulling out a handle, turning it counterclockwise and pushing the top of the door inward slightly.

A door can be opened from the inside by a tee handle, which is pushed in, turned clockwise, then used to lift the door inward.

The inner handle is normally safety-locked by a thin wire which breaks when operated.

The door runs down on tracks and transfers to a hinged carrier which, in turn, swings downward and stows the door under the fuselage. Turning the handle withdraws two locking bolts: the forward bolt initiates a CARGO door unlocked warning on the flight deck. A luminous indicator is fitted to each locking bolt on both freight doors.

The door is closed by manually releasing the carrier support lock and lifting the door until rollers on the carrier engage in the door frame tracks, then pulled up to the fully closed position. Rotating the handle extends the locking bolts which hold the door in the locked position. The handle is spring-returned into its recess. The luminous indicators are visible when the locking bolts are engaged and are viewed through inspection windows in the door.

REAR PRESSURE BULKHEAD DOOR

The door opens into the passenger cabin from the rear pressure bulkhead. It is opened from either side by pushing the handle down to disengage two latches and swinging the door into a recess in the rear toilet wall where it remains in position.

Initial movement of the door handle retracts two latches, which secure the door in the locked position, one of which initiates a REAR PASS door warning on the flight deck.

ELECTRICS AND ELECTRONICS (RADIO) BAY DOORS

These doors are similar in construction and have spider mechanisms operated by external retractable handles.

To remove the door, the handle is PRESS released and rotated to withdraw the four locking bolts; the door is then free to be pushed inward, turned, tilted and withdrawn from the fuselage.

Two pressure seals are fitted to the door, one between the door handle shaft and its housing and the other to the periphery of the door.

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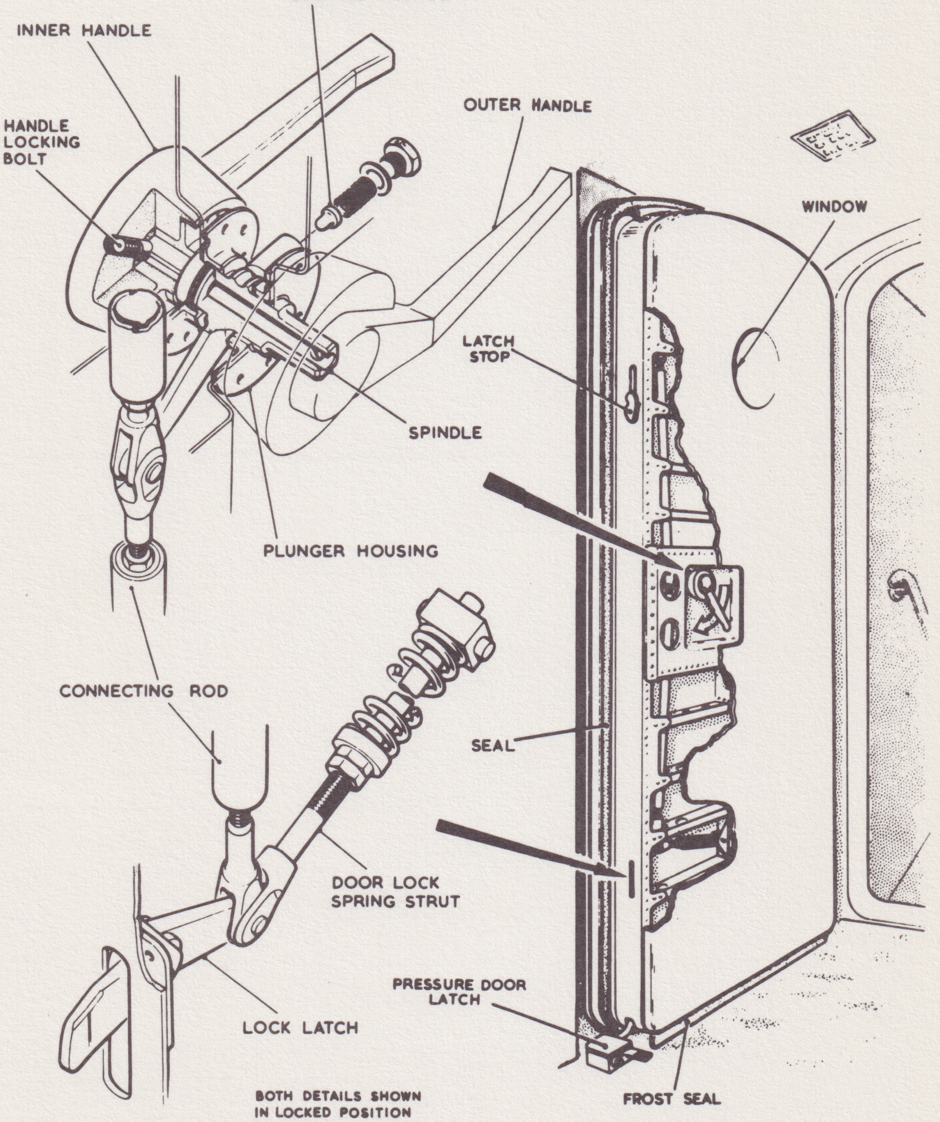
LOCKING PLUNGER
INNER HANDLE
OUTER HANDLE
HANDLE LOCKING BOLT
WINDOW
LATCH STOP
SPINDLE
PLUNGER HOUSING
CONNECTING ROD
SEAL
DOOR LOCK SPRING STRUT
PRESSURE DOOR LATCH
LOCK LATCH
FROST SEAL
BOTH DETAILS SHOWN IN LOCKED POSITION
AB52/633A

Rear Passenger Door
Figure 11

ELECTRICAL POWER

General

The aircraft generating system is based on three independent 30 kVA (nominal) constant-frequency generating channels supplying 200/115-volts, 3-phase a.c. power at 400 c/s.

Two generators, one mounted on each engine, are driven through constant-speed drive and engine start (CSDS) units and supply main a.c. power through separate channels to two a.c. main bus-bars. The aircraft electrical loads are shared between these two channels.

A third generator mounted on, and driven by, a constant-speed auxiliary power unit (APU) is available to supply a.c. power through a third channel to the main bus-bars for ground servicing requirements. This channel can also be used to substitute for either main channel in the event of a failure.

A main transformer rectifier unit (TRU) is connected to each a.c. channel and these two TRU's convert part of the a.c. supply to power a 28-volt d.c. distribution system. Two lead-acid batteries are connected to this system to provide power for starting the APU and, if both TRUs fail, to maintain the essential services.

Two plugs are provided for the connection of external power supplies, (see Section 1-9-0). One enables an external source of 200/115-volts, 3-phase, 400-c/s a.c. power to be connected to the aircraft system; automatic controls ensure that no two a.c. power sources can be connected in parallel and that the aircraft main generators are dominant on the a.c. main bus-bars. The second plug enables an external source of 28-volt d.c. power to be connected for starting the APU.

The loss of the power supply from either main channel caused by a failure of any nature other than overloading, results in automatic interconnection of the a.c. main bus-bars. Since the aircraft electrical load, including standard galley and air conditioning loads, is less than the continuous full load rating of one generator, the continuity of supply to all services is ensured under single-channel supply conditions, but those parts of the galley and air conditioning loads which exceed the standard aircraft provision are automatically shed. The loss of the power supplies from both main channels, caused by failures of any nature, results in all but the a.c. and d.c. essential loads being automatically shed. The batteries then maintain the continuity of supply to the d.c. essential loads, and the static inverter is automatically brought into operation to supply the a.c. essential loads. However, the system is so arranged that, with the APU running, the APU generator channel is automatically substituted for the 'off line' main channel(s); starting the APU after a main channel failure effects the same result.

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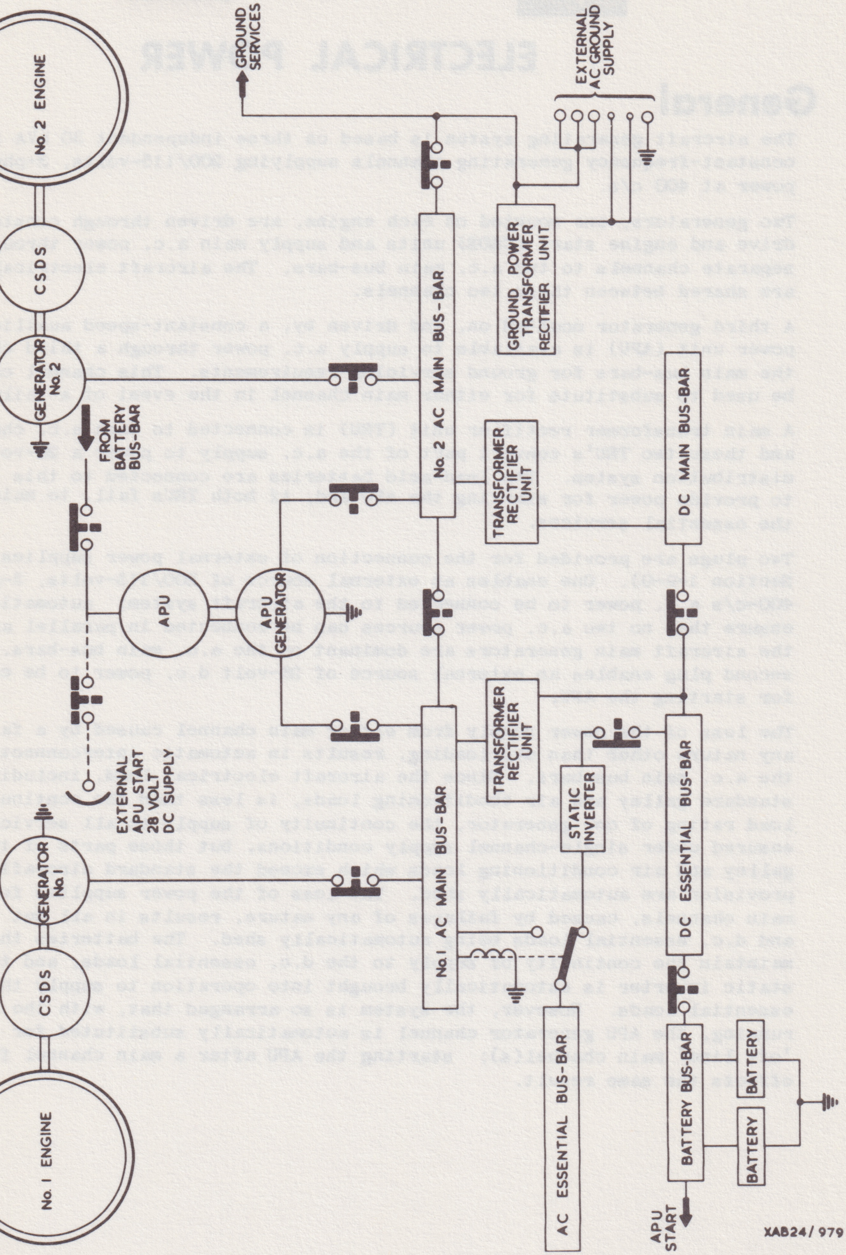
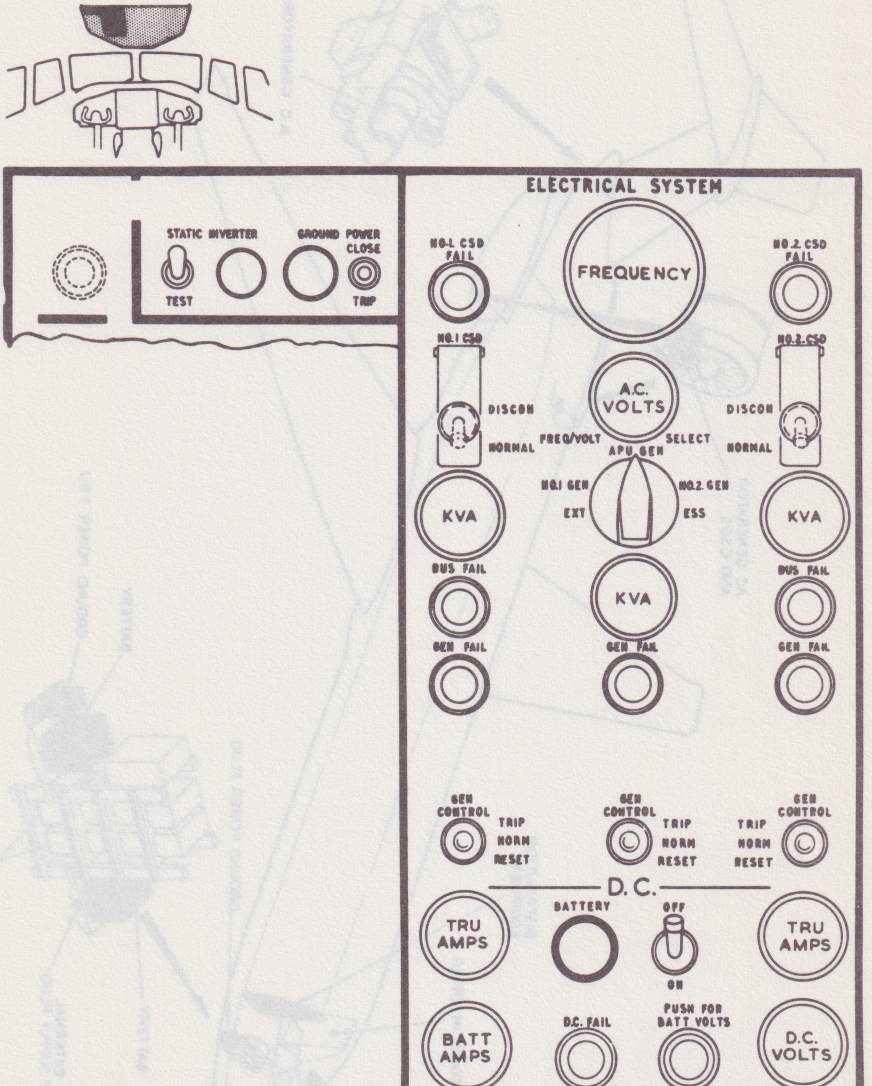

GROUND SERVICES
EXTERNAL AC GROUND SUPPLY
No. 2 ENGINE
CSDS
GENERATOR No. 2
FROM BATTERY BUS-BAR
No. 2 AC MAIN BUS-BAR
GROUND POWER TRANSFORMER RECTIFIER UNIT
TRANSFORMER RECTIFIER UNIT
DC MAIN BUS-BAR
APU
APU GENERATOR
EXTERNAL APU START 28 VOLT DC SUPPLY
GENERATOR No. 1
CSDS
No. 1 ENGINE
No. 1 AC MAIN BUS-BAR
TRANSFORMER RECTIFIER UNIT
STATIC INVERTER
DC ESSENTIAL BUS-BAR
AC ESSENTIAL BUS-BAR
BATTERY BUS-BAR
BATTERY
BATTERY
APU START
XAB24/979

Power Distribution - Schematic Diagram
Figure 1


STATIC INVERTER
TEST
GROUND POWER
CLOSE
TRIP
ELECTRICAL SYSTEM
NO.1 CSD FAIL
FREQUENCY
NO.2 CSD FAIL
NO.1 CSD
DISCON
NORMAL
A.C. VOLTS
NO.2 CSD
DISCON
NORMAL
FREQ/VOLT SELECT
APU GEN
NO.1 GEN
NO.2 GEN
EXT
ESS
KVA
KVA
KVA
BUS FAIL
BUS FAIL
GEN FAIL
GEN FAIL
GEN FAIL
GEN CONTROL
TRIP
NORM
RESET
GEN CONTROL
TRIP
NORM
RESET
GEN CONTROL
TRIP
NORM
RESET
D.C.
TRU AMPS
BATTERY
OFF
ON
TRU AMPS
BATT AMPS
D.C. FAIL
PUSH FOR BATT VOLTS
D.C. VOLTS

AB 24/355 A

Typical Controls and Indicators
Figure 2

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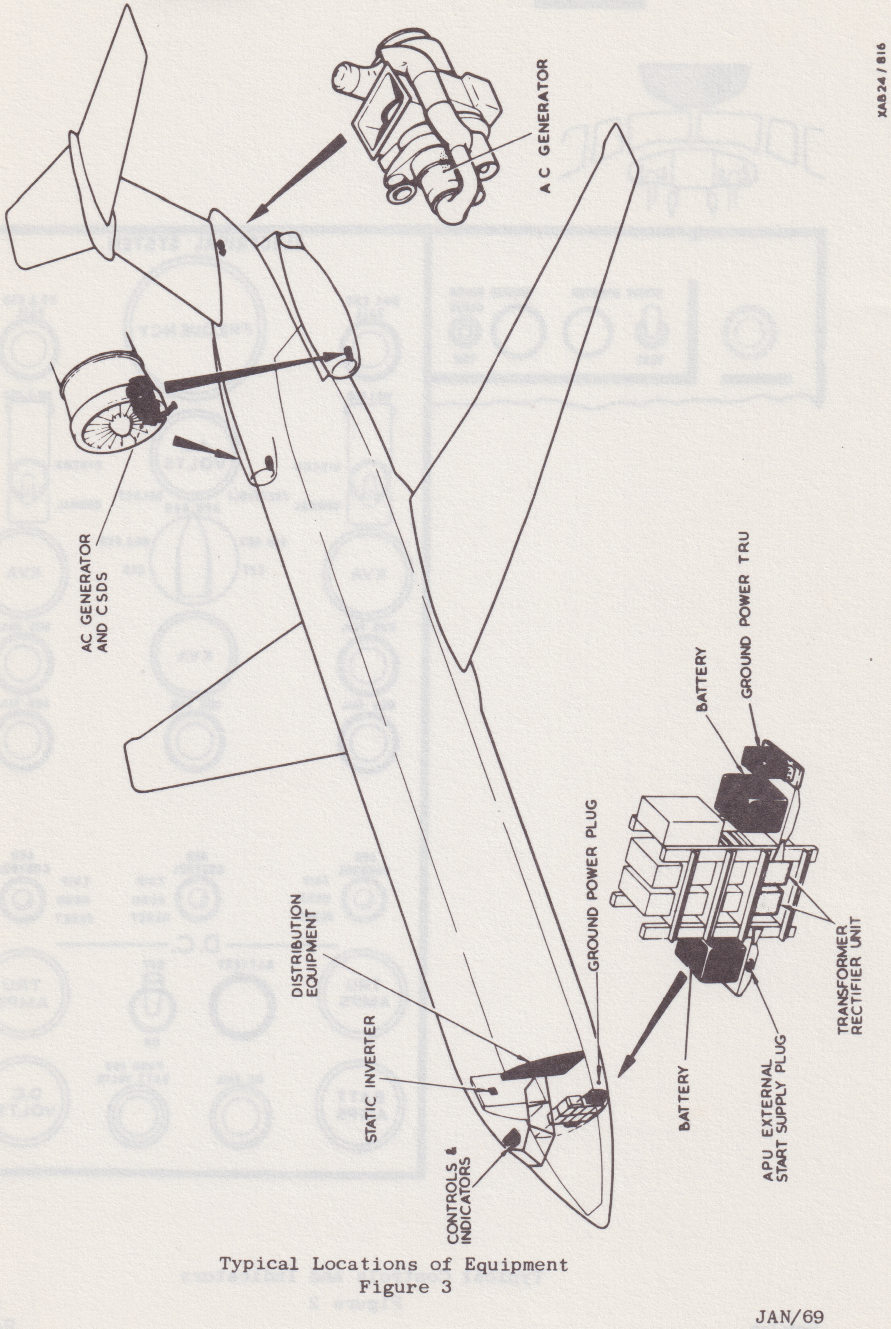
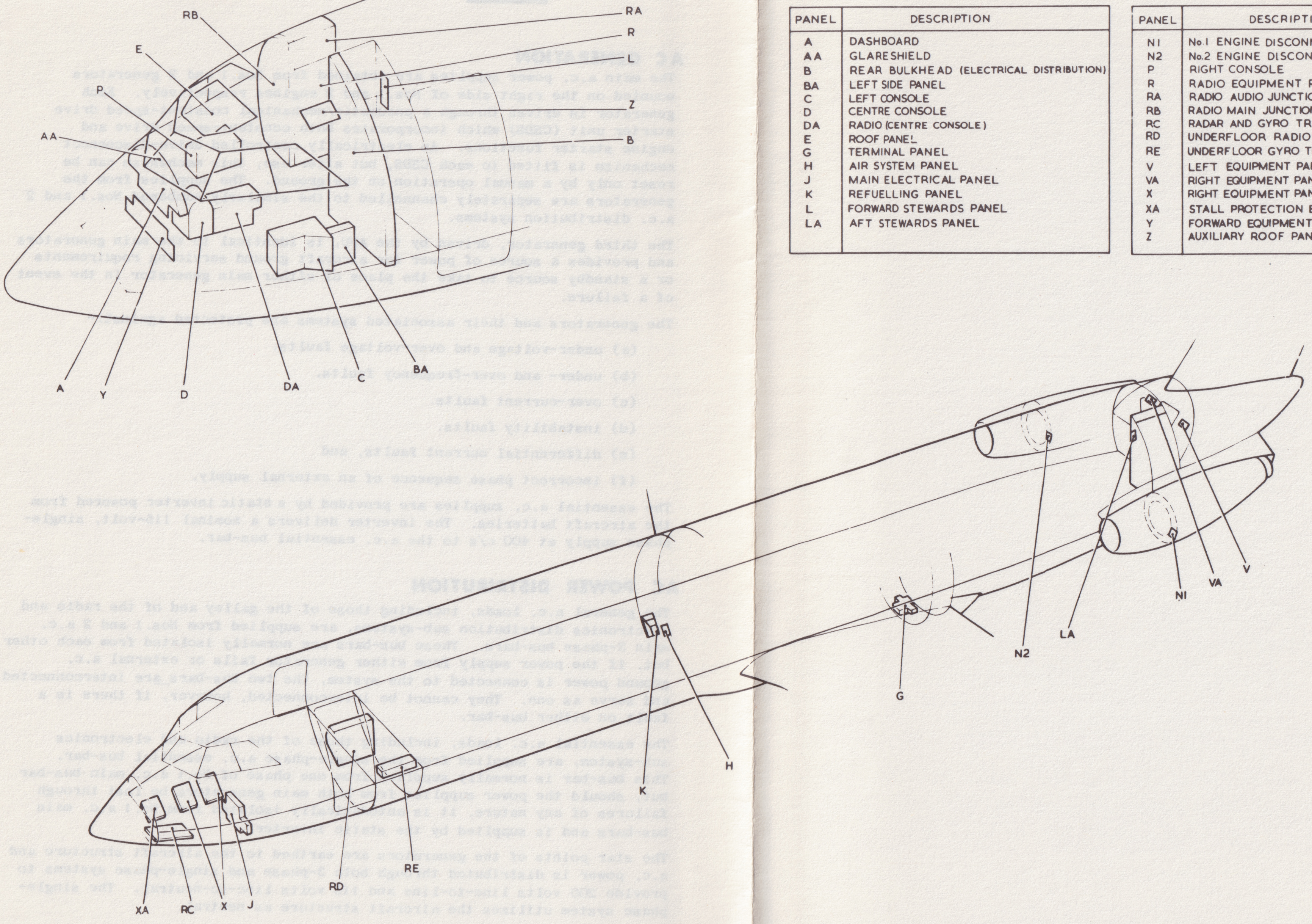

A C GENERATOR
XA824 / 816
AC GENERATOR AND CSDS
BATTERY
GROUND POWER TRU
GROUND POWER PLUG
DISTRIBUTION EQUIPMENT
TRANSFORMER RECTIFIER UNIT
STATIC INVERTER
BATTERY
APU EXTERNAL START SUPPLY PLUG
CONTROLS & INDICATORS

Typical Locations of Equipment
Figure 3



PANEL	DESCRIPTION
A	DASHBOARD
AA	GLARESHIELD
B	REAR BULKHEAD (ELECTRICAL DISTRIBUTION)
BA	LEFT SIDE PANEL
C	LEFT CONSOLE
D	CENTRE CONSOLE
DA	RADIO (CENTRE CONSOLE)
E	ROOF PANEL
G	TERMINAL PANEL
H	AIR SYSTEM PANEL
J	MAIN ELECTRICAL PANEL
K	REFUELLING PANEL
L	FORWARD STEWARDS PANEL
LA	AFT STEWARDS PANEL

PANEL	DESCRIPTION
N1	No.1 ENGINE DISCONNECT PANEL
N2	No.2 ENGINE DISCONNECT PANEL
P	RIGHT CONSOLE
R	RADIO EQUIPMENT RACK
RA	RADIO AUDIO JUNCTION BOX
RB	RADIO MAIN JUNCTION BOX
RC	RADAR AND GYRO TRAY
RD	UNDERFLOOR RADIO RACK
RE	UNDERFLOOR GYRO TRAY
V	LEFT EQUIPMENT PANEL
VA	RIGHT EQUIPMENT PANEL
X	RIGHT EQUIPMENT PANEL
XA	STALL PROTECTION EQUIPMENT PANEL
Y	FORWARD EQUIPMENT PANEL
Z	AUXILIARY ROOF PANEL

XAB24/1004

Location of Panels and Seals
Figure 4

AC GENERATION

The main a.c. power supplies are obtained from Nos. 1 and 2 generators mounted on the right side of Nos. 1 and 2 engines respectively. Each generator is driven through a pneumatic/mechanical constant-speed drive starter unit (CSDS) which incorporates both constant-speed drive and engine starter functions. An electrically controlled drive-disconnect mechanism is fitted to each CSDS, but after use, this mechanism can be reset only by a manual operation on the ground. The supplies from the generators are separately channelled to the similarly numbered Nos. 1 and 2 a.c. distribution systems.

The third generator, driven by the APU, is identical to the main generators and provides a source of power for aircraft ground servicing requirements or a standby source to take the place of either main generator in the event of a failure.

The generators and their associated systems are protected against:-

(a) under-voltage and over-voltage faults.

(b) under- and over-frequency faults.

(c) over-current faults.

(d) instability faults.

(e) differential current faults, and

(f) incorrect phase sequence of an external supply.

The essential a.c. supplies are provided by a static inverter powered from the aircraft batteries. The inverter delivers a nominal 115-volt, single-phase supply at 400 c/s to the a.c. essential bus-bar.

AC POWER DISTRIBUTION

The general a.c. loads, including those of the galley and of the radio and electronics distribution sub-systems, are supplied from Nos. 1 and 2 a.c. main 3-phase bus-bars. These bus-bars are normally isolated from each other but, if the power supply from either generator fails or external a.c. ground power is connected to the system, the two bus-bars are interconnected and serve as one. They cannot be interconnected, however, if there is a fault on either bus-bar.

The essential a.c. loads, including those of the radio and electronics sub-system, are supplied from the single-phase a.c. essential bus-bar. This bus-bar is normally supplied from one phase of No. 1 a.c. main bus-bar but, should the power supplies from both main generators be lost through failures of any nature, it is automatically isolated from No. 1 a.c. main bus-bars and is supplied by the static inverter.

The star points of the generators are earthed to the aircraft structure and a.c. power is distributed through both 3-phase and single-phase systems to provide 200 volts line-to-line and 115 volts line-to-neutral. The single-phase system utilizes the aircraft structure as neutral.

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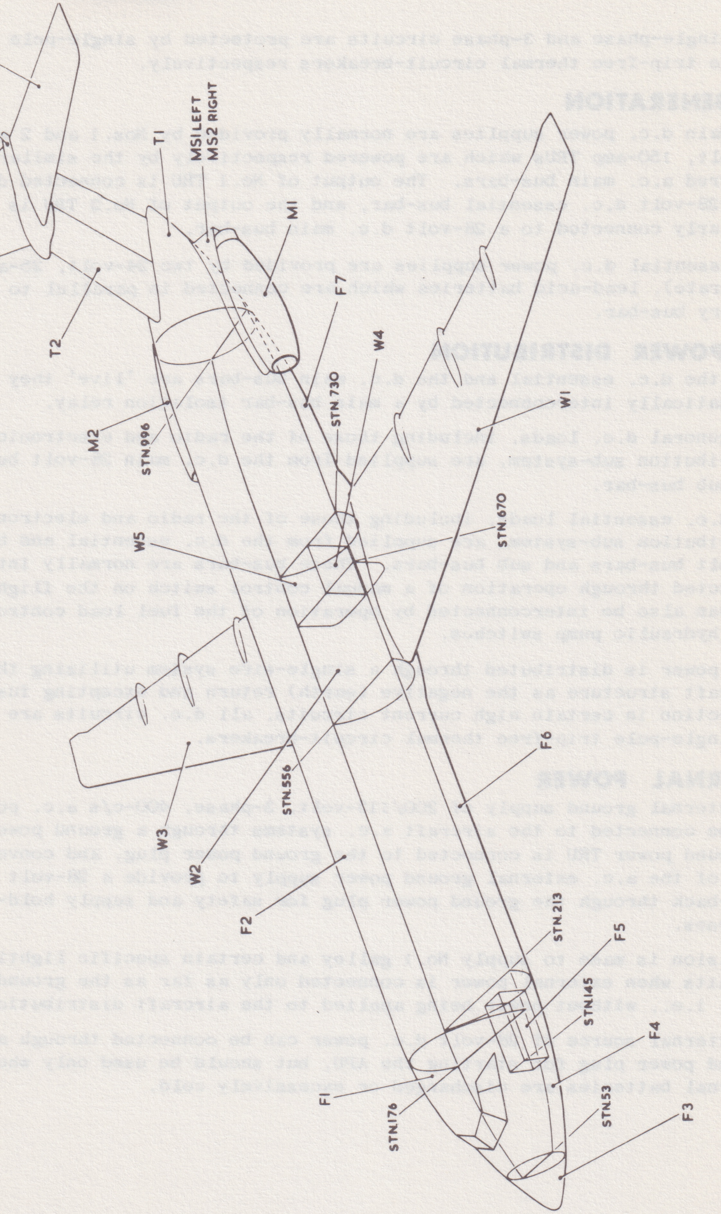

T4
T3
T5
T1
MS1 LEFT
MS2 RIGHT
M1
T2
F7
W4
W1
M2
STN.996
STN 730
W5
STN.670
F6
STN.556
W3
W2
F2
STN.213
F5
STN.145
F4
F1
STN.176
STN.53
F3

NOTE:- 1 ZONE W4 OR W5 INCLUDES THE LANDING GEAR BAY IN WING
2 ZONE M IS ENGINE ONLY, ZONE MS1 AND MS2 ARE ENGINE STUBS AND STRUCTURE AFTER ENGINES HAVE BEEN REMOVED

XAB24/810

Arrangement of Electrical Zones
Figure 5

All single-phase and 3-phase circuits are protected by single-pole and 3-pole trip-free thermal circuit-breakers respectively.

DC GENERATION

The main d.c. power supplies are normally provided by Nos. 1 and 2 main, 28-volt, 150-amp TRUs which are powered respectively by the similarly numbered a.c. main bus-bars. The output of No. 1 TRU is connected directly to a 28-volt d.c. essential bus-bar, and the output of No. 2 TRU is similarly connected to a 28-volt d.c. main bus-bar.

The essential d.c. power supplies are provided by two 24-volt, 25-aH (one hour rate), lead-acid batteries which are connected in parallel to a battery bus-bar.

DC POWER DISTRIBUTION

When the d.c. essential and the d.c. main bus-bars are 'live' they are automatically interconnected by a main bus-bar isolation relay.

The general d.c. loads, including those of the radio and electronics distribution sub-system, are supplied from the d.c. main 28-volt bus-bar and sub bus-bar.

The d.c. essential loads, including those of the radio and electronics distribution sub-system, are supplied from the d.c. essential and battery 28-volt bus-bars and sub bus-bars. These bus-bars are normally interconnected through operation of a manual control switch on the flight deck, but can also be interconnected by operation of the fuel load control or d.c. hydraulic pump switches.

D.c. power is distributed through a single-wire system utilizing the aircraft structure as the negative (earth) return and excepting fuse protection in certain high current circuits, all d.c. circuits are protected by single-pole trip-free thermal circuit-breakers.

EXTERNAL POWER

An external ground supply of 200/115-volt, 3-phase, 400-c/s a.c. power can be connected to the aircraft a.c. systems through a ground power plug. A ground power TRU is connected to the ground power plug, and converts part of the a.c. external ground power supply to provide a 28-volt d.c. feed-back through the ground power plug for safety and supply hold-on purposes.

Provision is made to supply No. 1 galley and certain specific lighting circuits when external power is connected only as far as the ground power plug, i.e., without power being applied to the aircraft distribution system.

An external source of 28-volt d.c. power can be connected through a d.c. ground power plug for starting the APU, but should be used only when the internal batteries are discharged or excessively cold.

CONTROLS AND INDICATORS

Separate switches are provided for the control of the power supplies from all primary sources. These switches are arranged in a logical pattern, together with voltage, amperage, frequency and kVA meters, and failure warning lamps which adequately monitor the aircraft power system.

LOCATION OF EQUIPMENT

The majority of the electrical power equipment is located either in a forward underfloor compartment or on the flight deck. Nos. 1 and 2 main TRUs and batteries are racked in, or mounted on, the underfloor main electrical panel (Panel J). On the flight deck, the d.c. distribution sub bus-bars ; associated circuit-breakers are mounted in, or on, a right console (Panel P), but the majority of the distribution bus-bars and equipment together with the associated circuit-breakers is mounted in, or on, a rear bulkhead (Panel B); the control switches, meters and warning lamps are mounted on roof panel E. The a.c. generating system control and protection equipment is mounted in, or on, both Panel J and Panel B. The a.c. ground power plug is located behind an access panel, forward of the nose undercarriage bay, on the left underside of the fuselage. The ground power TRU is located adjacent to Panel J.

ELECTRICAL ZONES

The aircraft is divided into specific zones for convenient referencing and location of electrical equipment. Within each zone every item of electrical equipment can be located by a reference number painted, or otherwise marked, on the panel or structure adjacent to the equipment.

WIRING

Generally, Minyvin cables are used except where the nature of the operating conditions precludes their use; particular requirements being met by the use of either Tersil or Efglas. Mainly standard A-MP ring-type pre-insulated cable terminations are used throughout the aircraft but special high-temperature A-MP ring-type terminations, which are not pre-insulated, are used in high-temperature areas.

Cables carrying supplies to vital circuits are segregated where possible by running them in separate cable ducts or by the use of dividers within a duct. In addition, in those circuits where reversal of connections constitutes a hazard, terminals are polarized, connectors orientated, or stocks are fitted to cables to prevent inadvertent reversal.

As far as possible cables are run in ducts and conduits, and generally easy access to the cables is made possible. Where access is difficult, spare cables or draw cords are provided in each loom.

CONTROL

The operation of the aircraft power systems is initiated by operating the battery switch on the flight deck roof panel and all subsequent operations automatically follow when the aircraft engines, or the APU, are started. Other switches can be used for resetting the a.c. generation channels if they are tripped by the operation of automatic protection circuits, or for tripping them if required. The disconnect operation of the CSDS disconnect mechanism, a static inverter test facility and the electrical connection of an external a.c. power supply are also controlled by switches on the roof panel.

EQUIPMENT/FURNISHINGS

General

Accommodation above the floor is at one level, consisting principally of a pressurized air-conditioned and sound-proofed flight deck and passenger cabin.

Below the floor, two freight holds are provided.

A variety of materials are used for the furnishings, and recommended cleaners/ polishes are included in Section 1-7-0.

FLIGHT DECK

Access to the flight deck is via the forward vestibule.

Seating is basically for captain, co-pilot and observer, and on some Models the area behind the pilots' seat is equipped with a visitors seat mounted on the electrical bulkhead.

Alternatively, this area is developed into a navigators or radio operators station, with a turntable-mounted seat.

The captains' and co-pilots' seats are track-mounted, allowing forward and rearward adjustment. The observers seat is mounted on a transverse-sliding beam, and stows behind the co-pilots' seat when not in use. Side consoles at each pilots' position form part of the sidewall furnishings and house various controls and equipment stowages.

A furnished radio rack is located on the right-hand side of the flight deck.

PASSENGER CABIN And VESTIBULES

The layout differs considerably between Models. Basically, provision is made for the installation of three galley units, and multi-position seat rails in the floor allow for a variety of seating configurations to suit Operator's requirements.

Overhead hatracks are standard, and these are equipped with passenger service panels, corresponding to the seat positions, which can be adjusted should the configuration be altered.

Both vestibules are equipped with attendants seats, the rear one operating similarly to the observers' on the flight deck.

Furnishing panels are retained in most cases by quick-release spire fasteners and are easily removable for maintenance purposes.

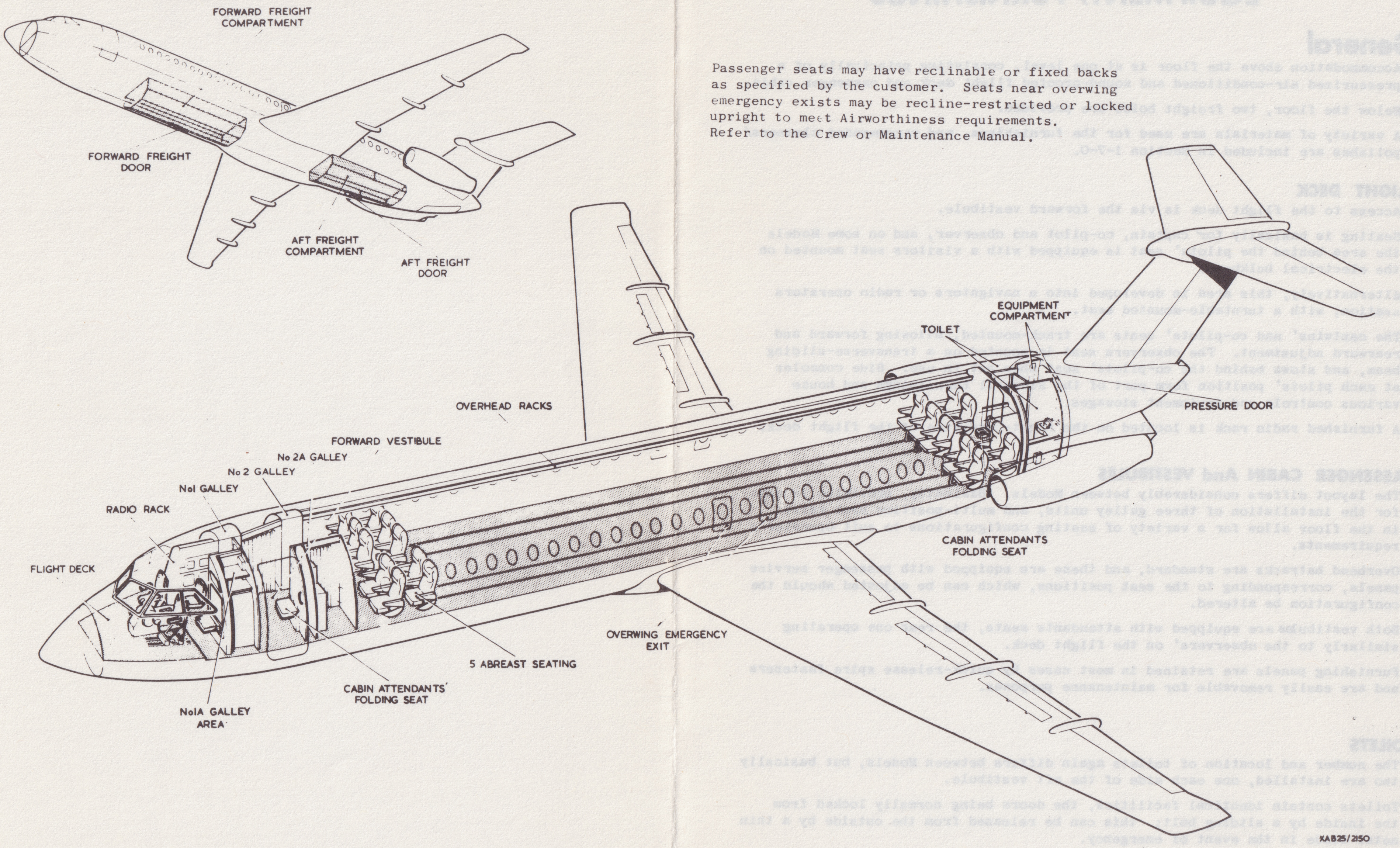
TOILETS

The number and location of toilets again differs between Models, but basically two are installed, one each side of the aft vestibule.

Toilets contain identical facilities, the doors being normally locked from the inside by a sliding bolt; this can be released from the outside by a thin metal blade in the event of emergency.

Toilet servicing is in Section 2-16-0.

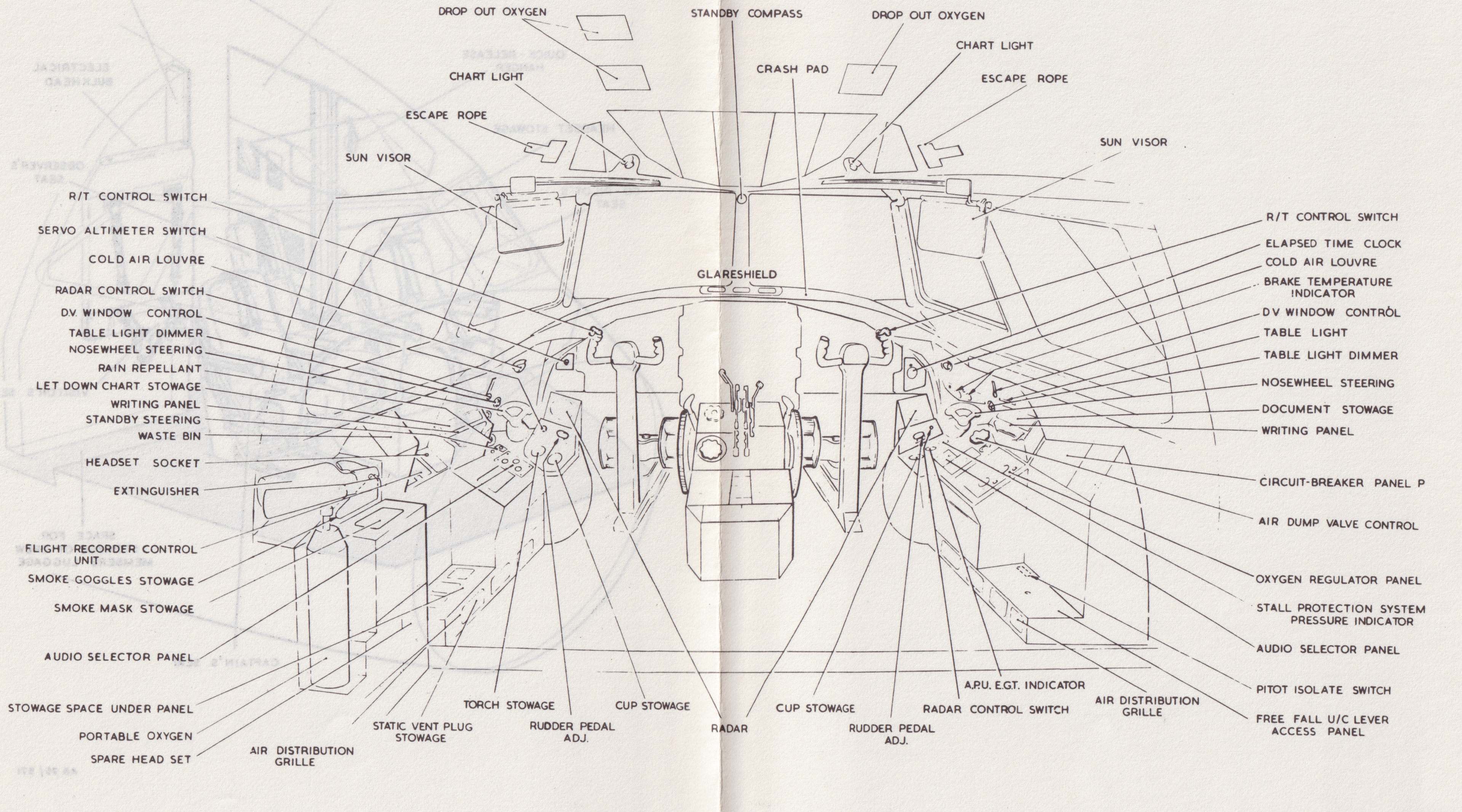
B068126


FORWARD FREIGHT COMPARTMENT
FORWARD FREIGHT DOOR
AFT FREIGHT COMPARTMENT
AFT FREIGHT DOOR
EQUIPMENT COMPARTMENT
TOILET
PRESSURE DOOR
OVERHEAD RACKS
FORWARD VESTIBULE
No 2A GALLEY
No 2 GALLEY
No1 GALLEY
RADIO RACK
FLIGHT DECK
CABIN ATTENDANTS FOLDING SEAT
OVERWING EMERGENCY EXIT
5 ABREAST SEATING
CABIN ATTENDANTS' FOLDING SEAT
No1A GALLEY AREA
XAB25/2150

Passenger seats may have reclinable or fixed backs as specified by the customer. Seats near overwing emergency exists may be recline-restricted or locked upright to meet Airworthiness requirements. Refer to the Crew or Maintenance Manual.

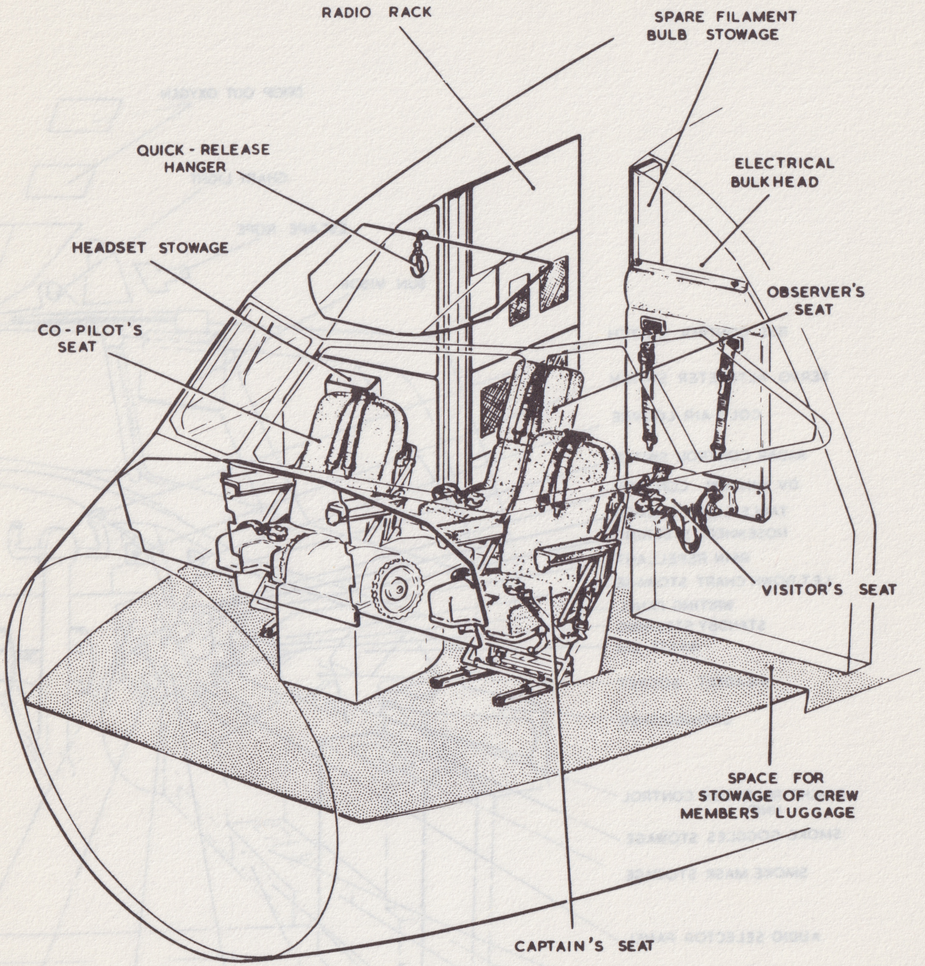
B07974-5

Typical G.A. of Equipment and Furnishings
Figure 1


DROP OUT OXYGEN
STANDBY COMPASS
DROP OUT OXYGEN
CHART LIGHT
CRASH PAD
CHART LIGHT
ESCAPE ROPE
ESCAPE ROPE
SUN VISOR
SUN VISOR
GLARESHIELD
R/T CONTROL SWITCH
SERVO ALTIMETER SWITCH
COLD AIR LOUVRE
RADAR CONTROL SWITCH
D.V. WINDOW CONTROL
TABLE LIGHT DIMMER
NOSEWHEEL STEERING
RAIN REPELLANT
LET DOWN CHART STOWAGE
WRITING PANEL
STANDBY STEERING
WASTE BIN
HEADSET SOCKET
EXTINGUISHER
FLIGHT RECORDER CONTROL UNIT
SMOKE GOGGLES STOWAGE
SMOKE MASK STOWAGE
AUDIO SELECTOR PANEL
STOWAGE SPACE UNDER PANEL
PORTABLE OXYGEN
SPARE HEAD SET
AIR DISTRIBUTION GRILLE
STATIC VENT PLUG STOWAGE
TORCH STOWAGE
RUDDER PEDAL ADJ.
CUP STOWAGE
RADAR
CUP STOWAGE
RUDDER PEDAL ADJ.
RADAR CONTROL SWITCH
A.P.U. E.G.T. INDICATOR
AIR DISTRIBUTION GRILLE
R/T CONTROL SWITCH
ELAPSED TIME CLOCK
COLD AIR LOUVRE
BRAKE TEMPERATURE INDICATOR
D.V WINDOW CONTROL
TABLE LIGHT
TABLE LIGHT DIMMER
NOSEWHEEL STEERING
DOCUMENT STOWAGE
WRITING PANEL
CIRCUIT-BREAKER PANEL P
AIR DUMP VALVE CONTROL
OXYGEN REGULATOR PANEL
STALL PROTECTION SYSTEM PRESSURE INDICATOR
AUDIO SELECTOR PANEL
PITOT ISOLATE SWITCH
FREE FALL U/C LEVER ACCESS PANEL
AB25/2060

Typical Flight Deck Equipment (1)
Figure 2

B070072


RADIO RACK
SPARE FILAMENT BULB STOWAGE
QUICK - RELEASE HANGER
ELECTRICAL BULKHEAD
HEADSET STOWAGE
OBSERVER'S SEAT
CO - PILOT'S SEAT
VISITOR'S SEAT
SPACE FOR STOWAGE OF CREW MEMBERS LUGGAGE
CAPTAIN'S SEAT

AB 25/571

Typical Flight Deck Equipment (2)

Figure 3

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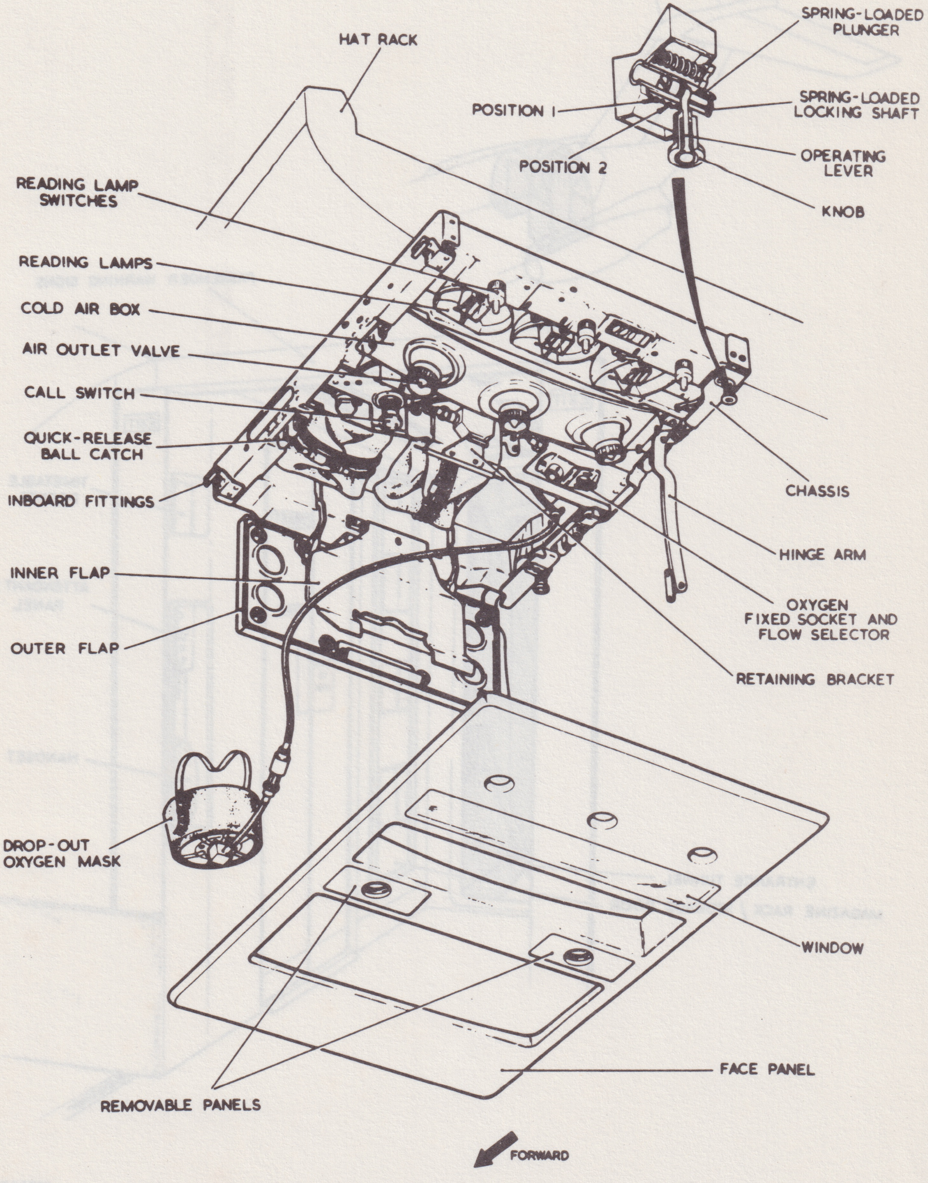
B068129

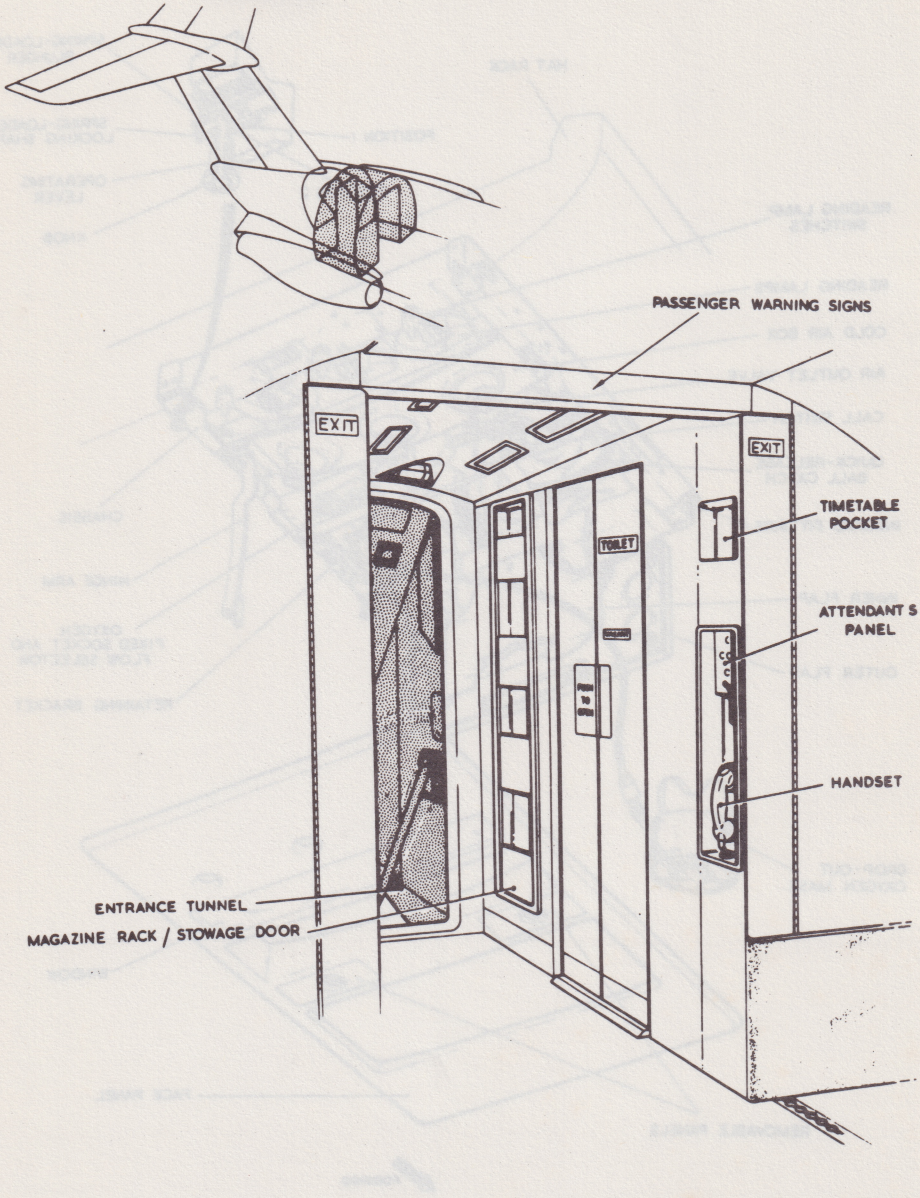
B06813


HAT RACK
SPRING-LOADED PLUNGER
POSITION 1
SPRING-LOADED LOCKING SHAFT
POSITION 2
OPERATING LEVER
KNOB
READING LAMP SWITCHES
READING LAMPS
COLD AIR BOX
AIR OUTLET VALVE
CALL SWITCH
QUICK-RELEASE BALL CATCH
CHASSIS
INBOARD FITTINGS
HINGE ARM
INNER FLAP
OXYGEN FIXED SOCKET AND FLOW SELECTOR
OUTER FLAP
RETAINING BRACKET
DROP-OUT OXYGEN MASK
WINDOW
FACE PANEL
REMOVABLE PANELS
FORWARD

AB 25/1631

Typical Passenger Service Panel

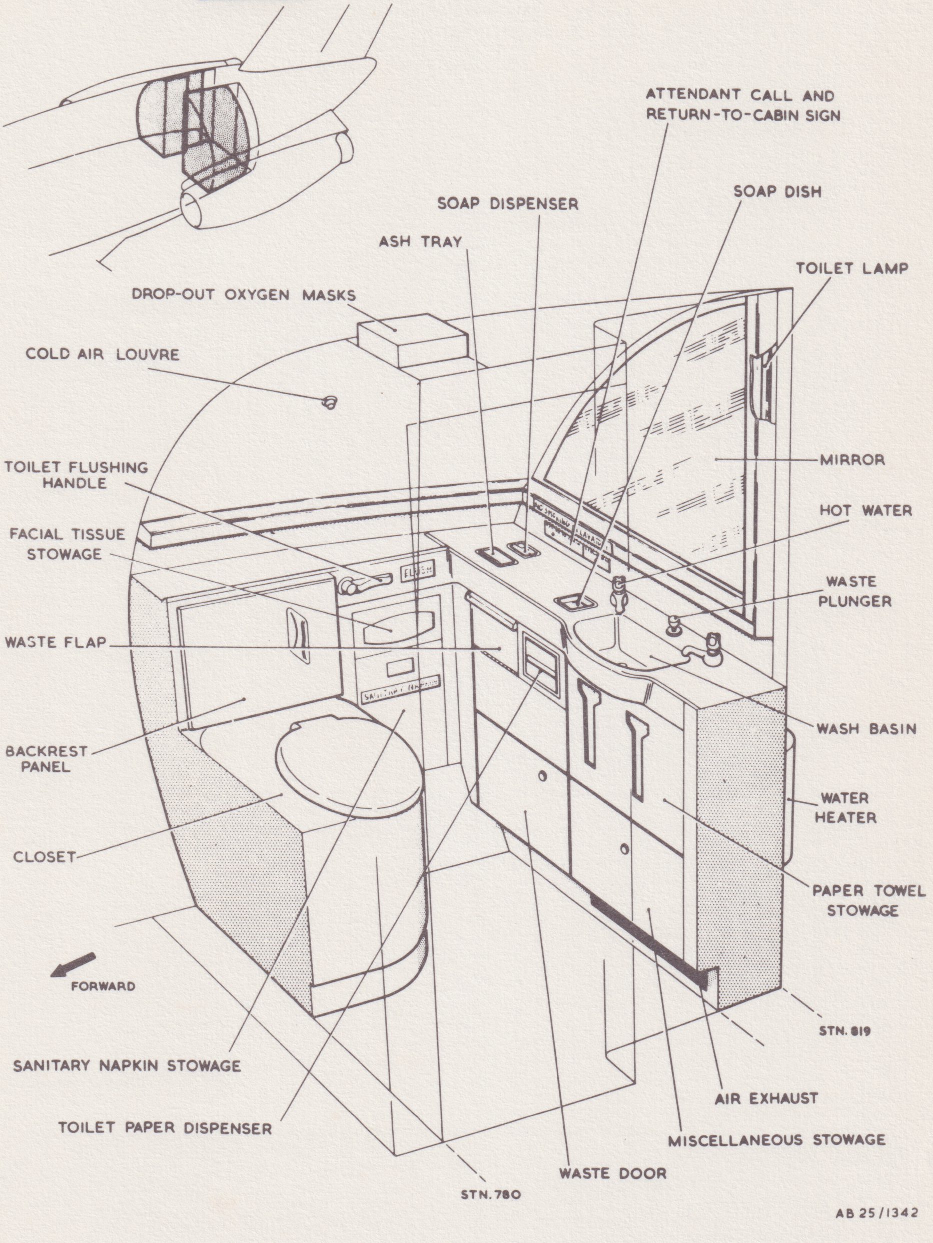
Figure 4


PASSENGER WARNING SIGNS
EXIT
EXIT
TOILET
PUSH TO OPEN
TIMETABLE POCKET
ATTENDANT S PANEL
HANDSET
ENTRANCE TUNNEL
MAGAZINE RACK / STOWAGE DOOR
XAB25/2982/

Typical Aft Vestibule
Figure 5

PRINTED IN ENGLAND

B06 32


ATTENDANT CALL AND RETURN-TO-CABIN SIGN
SOAP DISH
SOAP DISPENSER
ASH TRAY
TOILET LAMP
DROP-OUT OXYGEN MASKS
COLD AIR LOUVRE
MIRROR
TOILET FLUSHING HANDLE
HOT WATER
FACIAL TISSUE STOWAGE
FLUSH
WASTE PLUNGER
WASTE FLAP
WASH BASIN
BACKREST PANEL
WATER HEATER
CLOSET
PAPER TOWEL STOWAGE
FORWARD
STN. 819
SANITARY NAPKIN STOWAGE
AIR EXHAUST
TOILET PAPER DISPENSER
MISCELLANEOUS STOWAGE
WASTE DOOR
STN. 780
AB 25/1342

Typical G.A. of Right-hand Toilet (Left-hand Similar)
Figure 6

FIRE PROTECTION

General

The aircraft is protected against fire hazards by detection/warning, and extinguishing systems for the engine and APU installations.

Portable fire extinguishers are located in various positions throughout the flight deck and passenger cabin, and the freight holds are lined with fire-resistant material. In addition, each power unit is isolated from the fuselage by titanium bulkheads, and break-in panels provide access for outside fire-fighting while the aircraft is on the ground.

FIRE ZONES

Each engine nacelle is divided into two zones by a fireproof bulkhead; Zone 1 houses the combustion section, and Zone 2 surrounds the jet pipe.

Each Zone 1 and the APU compartment are fully equipped for fire detection and extinguishing.

Zones 2 are not designated fire zones but are associated with the engine overheat warning system, and as such are fitted only with detection equipment.

DETECTION/WARNING

A number of coaxially-connected wire sensing elements are routed through each of the engine and the APU compartments; these are energized and continuously monitored by control units powered from the a.c. essential bus-bar. When a fire condition is sensed, the control unit energizes the respective warning circuit, which is powered from the d.c. essential bus-bar, and causes the light in the associated fire control handle on the flight deck to come on; in addition, a bell inside the pilots' roof panel, rings, until cancelled by the bell isolating switch. Warning of an APU fire condition is also given externally by a light on the APU fire and shut-down panel.

Each of the three separate warning circuits can be checked by operating the respective FIRE HANDLE TEST switch, on the co-pilots' instrument panel but, before testing the APU circuit the FIRE AUTO/MANUAL switch on panel E must be set at MANUAL.

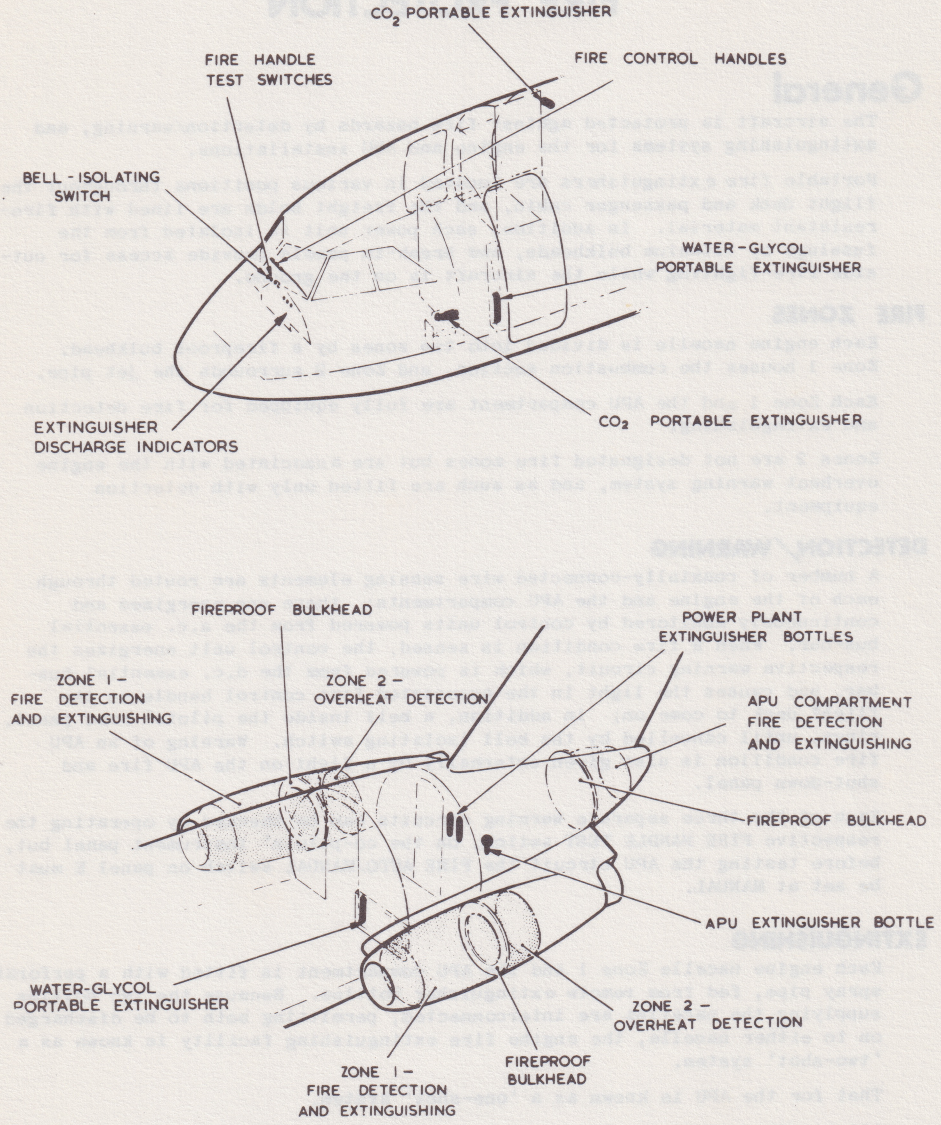
EXTINGUISHING

Each engine nacelle Zone 1 and the APU compartment is fitted with a perforated spray pipe, fed from remote extinguisher bottles. Because the two bottles supplying the nacelles are interconnected, permitting both to be discharged on to either nacelle, the engine fire extinguishing facility is known as a 'two-shot' system.

That for the APU is known as a 'one-shot' system.

All bottles are discharged by electrically-fired cartridges and incorporate pressure relief rupture discs to release the contents to atmosphere should high ambient temperature cause the bottle to pressurize beyond safe limits.

B06813


CO₂ PORTABLE EXTINGUISHER
FIRE HANDLE TEST SWITCHES
FIRE CONTROL HANDLES
BELL - ISOLATING SWITCH
WATER - GLYCOL PORTABLE EXTINGUISHER
EXTINGUISHER DISCHARGE INDICATORS
CO₂ PORTABLE EXTINGUISHER
FIREPROOF BULKHEAD
POWER PLANT EXTINGUISHER BOTTLES
ZONE 1 - FIRE DETECTION AND EXTINGUISHING
ZONE 2 - OVERHEAT DETECTION
APU COMPARTMENT FIRE DETECTION AND EXTINGUISHING
FIREPROOF BULKHEAD
APU EXTINGUISHER BOTTLE
WATER-GLYCOL PORTABLE EXTINGUISHER
ZONE 2 - OVERHEAT DETECTION
FIREPROOF BULKHEAD
ZONE 1 - FIRE DETECTION AND EXTINGUISHING
ABOO/6355

Arrangement of Fire Protection System

Figure 1

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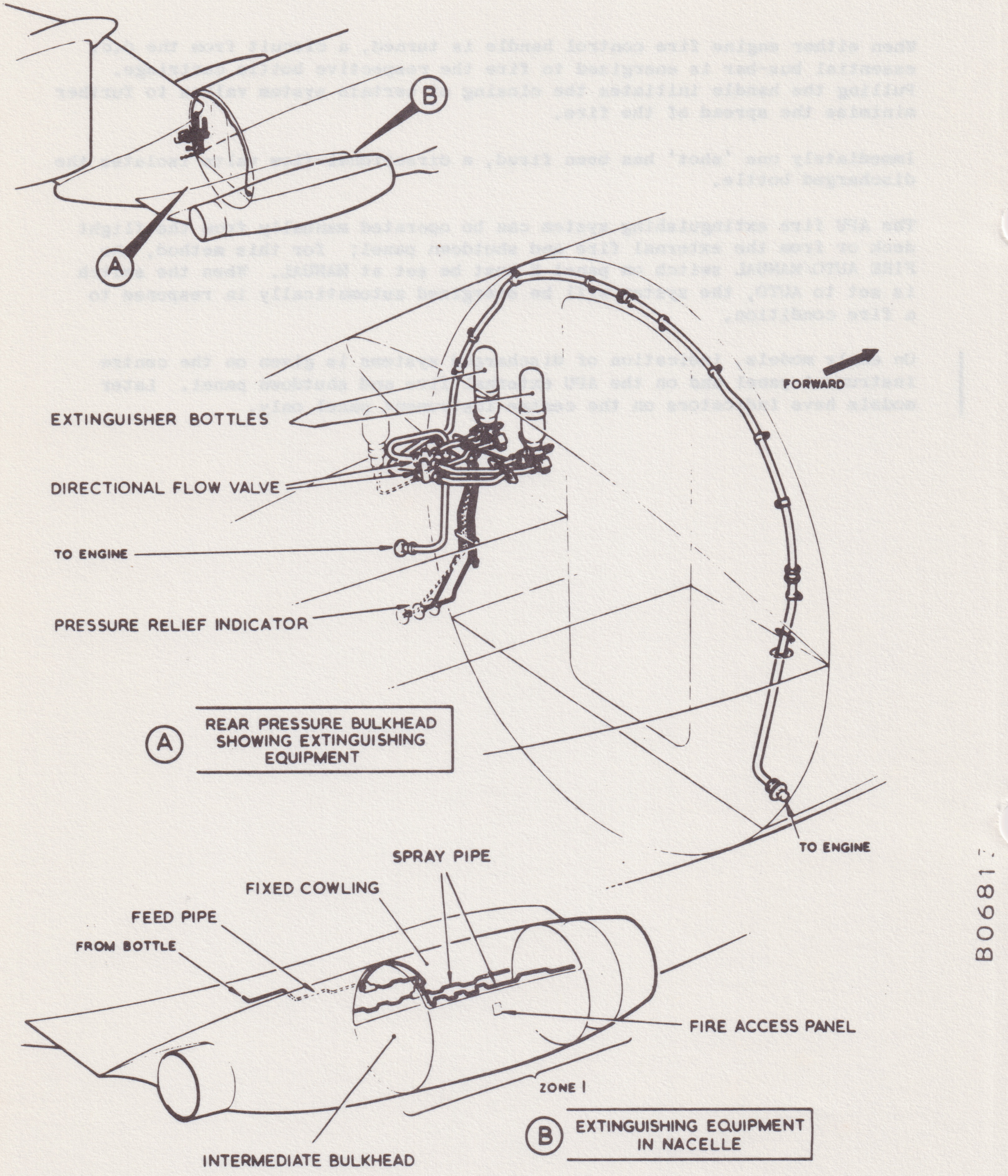
When either engine fire control handle is turned, a circuit from the d.c. essential bus-bar is energized to fire the respective bottle cartridge. Pulling the handle initiates the closing of certain system valves to further minimise the spread of the fire.

Immediately one 'shot' has been fired, a directional-flow valve isolates the discharged bottle.

The APU fire extinguishing system can be operated manually from the flight deck or from the external fire and shutdown panel; for this method, the FIRE AUTO/MANUAL switch on panel E must be set at MANUAL. When the switch is set to AUTO, the system will be energized automatically in response to a fire condition.

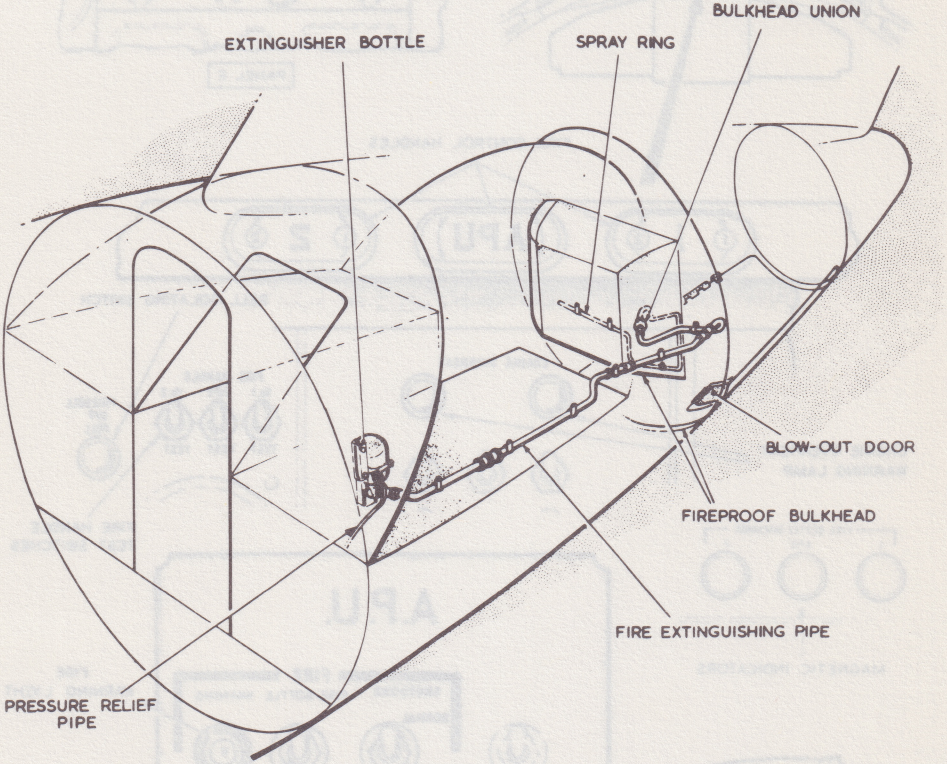
On early models, indication of discharged systems is given on the centre instrument panel and on the APU external fire and shutdown panel. Later models have indicators on the centre instrument panel only.


B
A
FORWARD
EXTINGUISHER BOTTLES
DIRECTIONAL FLOW VALVE
TO ENGINE
PRESSURE RELIEF INDICATOR
A
REAR PRESSURE BULKHEAD SHOWING EXTINGUISHING EQUIPMENT
TO ENGINE
B06817
SPRAY PIPE
FIXED COWLING
FEED PIPE
FROM BOTTLE
FIRE ACCESS PANEL
ZONE 1
B
EXTINGUISHING EQUIPMENT IN NACELLE
INTERMEDIATE BULKHEAD

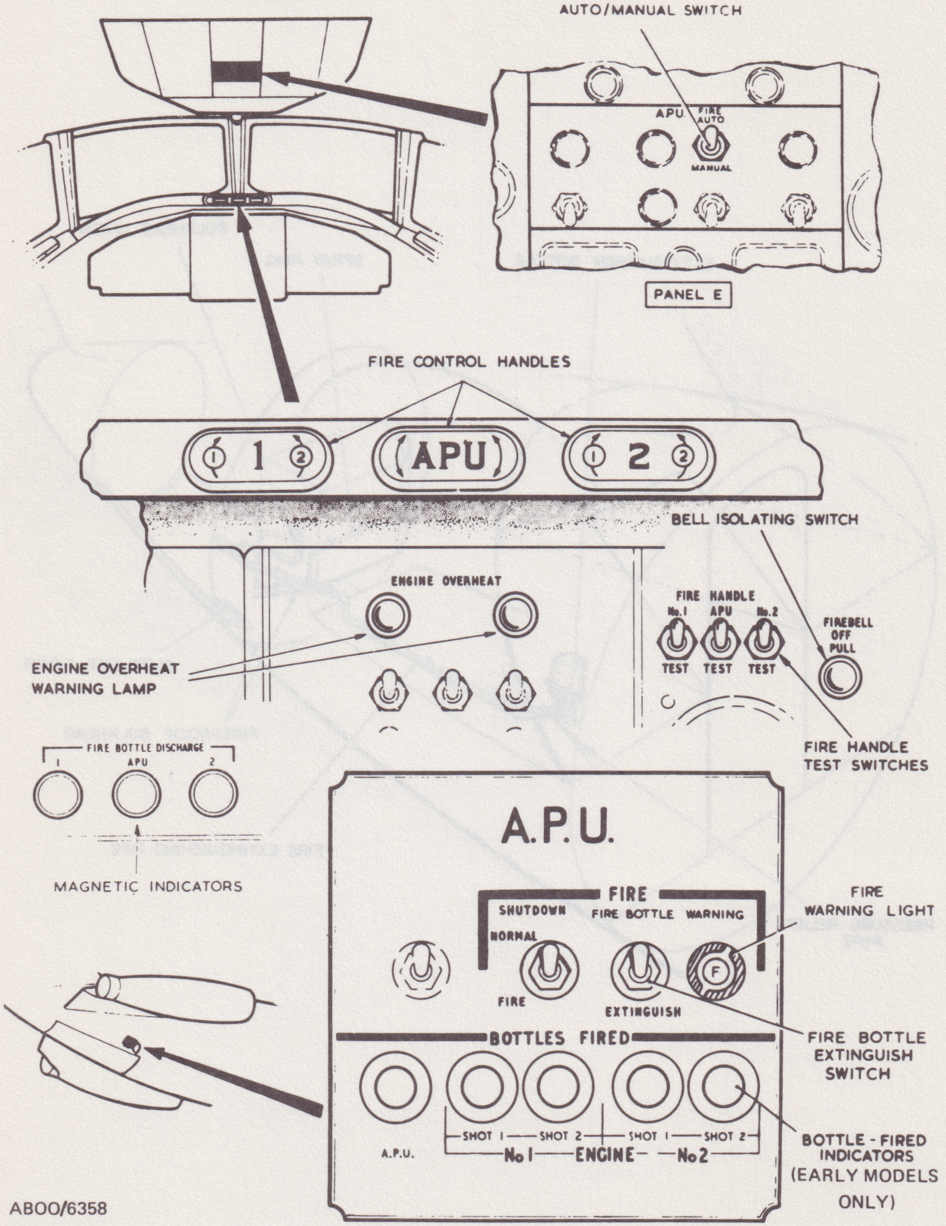
Arrangement of Engine Extinguishing Equipment

Figure 2

X024593


EXTINGUISHER BOTTLE
SPRAY RING
BULKHEAD UNION
BLOW-OUT DOOR
FIREPROOF BULKHEAD
FIRE EXTINGUISHING PIPE
PRESSURE RELIEF PIPE

Arrangement of APU Fire Extinguishing Equipment
Figure 3


AUTO/MANUAL SWITCH
APU
FIRE
AUTO
MANUAL
PANEL E
FIRE CONTROL HANDLES
1
APU
2
BELL ISOLATING SWITCH
ENGINE OVERHEAT
FIRE HANDLE
No.1
APU
No.2
TEST
TEST
TEST
FIREBELL
OFF
PULL
ENGINE OVERHEAT
WARNING LAMP
FIRE HANDLE
TEST SWITCHES
FIRE BOTTLE DISCHARGE
1
APU
2
MAGNETIC INDICATORS
A.P.U.
FIRE
SHUTDOWN
NORMAL
FIRE
FIRE BOTTLE
EXTINGUISH
WARNING
F
FIRE
WARNING LIGHT
BOTTLES FIRED
FIRE BOTTLE
EXTINGUISH
SWITCH
A.P.U.
SHOT 1
SHOT 2
SHOT 1
SHOT 2
No 1
ENGINE
No 2
BOTTLE - FIRED
INDICATORS
(EARLY MODELS
ONLY)
ABOO/6358

Controls and Indicators
Figure 4

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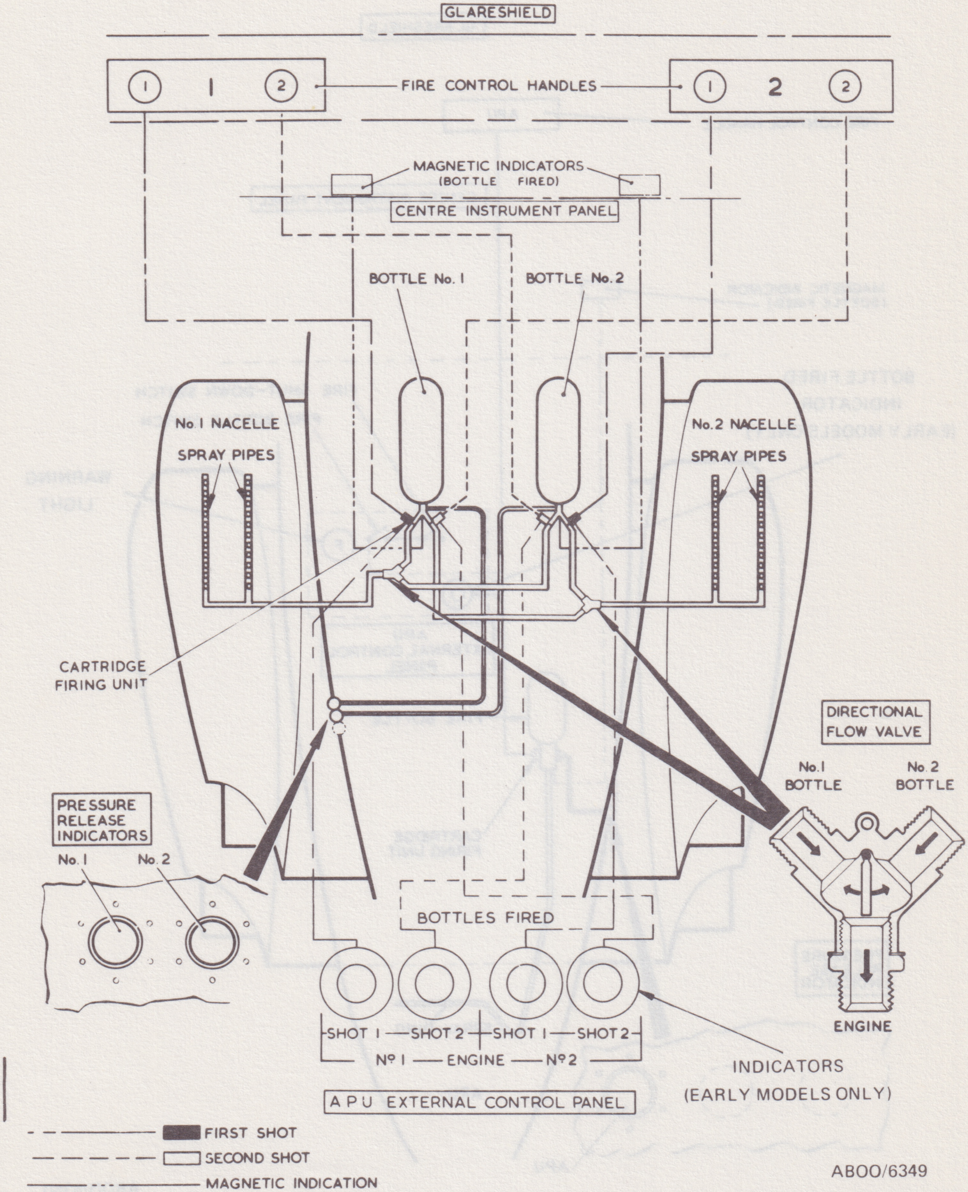
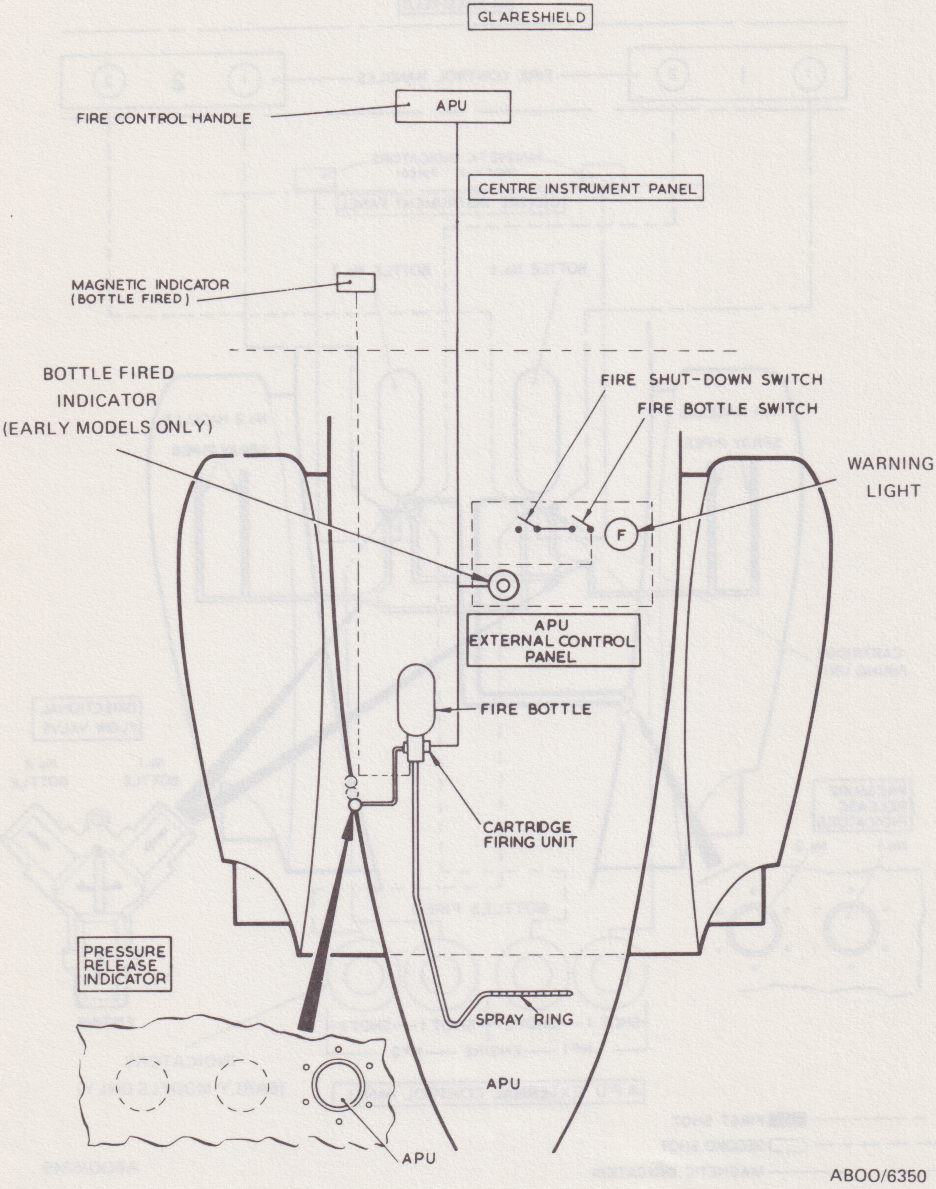
X024596

PRINTED IN ENGLAND

X024599


GLARESHIELD
FIRE CONTROL HANDLES
1
2
MAGNETIC INDICATORS (BOTTLE FIRED)
CENTRE INSTRUMENT PANEL
BOTTLE No. 1
BOTTLE No. 2
No. 1 NACELLE
SPRAY PIPES
No. 2 NACELLE
SPRAY PIPES
CARTRIDGE FIRING UNIT
DIRECTIONAL FLOW VALVE
No. 1 BOTTLE
No. 2 BOTTLE
ENGINE
PRESSURE RELEASE INDICATORS
No. 1
No. 2
BOTTLES FIRED
SHOT 1
SHOT 2
SHOT 1
SHOT 2
Nº 1
ENGINE
Nº 2
INDICATORS (EARLY MODELS ONLY)
APU EXTERNAL CONTROL PANEL
FIRST SHOT
SECOND SHOT
MAGNETIC INDICATION
ABOO/6349

Engine Fire Extinguishing Diagram
Figure 5


GLARESHIELD
APU
FIRE CONTROL HANDLE
CENTRE INSTRUMENT PANEL
MAGNETIC INDICATOR (BOTTLE FIRED)
BOTTLE FIRED INDICATOR (EARLY MODELS ONLY)
FIRE SHUT-DOWN SWITCH
FIRE BOTTLE SWITCH
WARNING LIGHT
F
APU EXTERNAL CONTROL PANEL
FIRE BOTTLE
CARTRIDGE FIRING UNIT
PRESSURE RELEASE INDICATOR
SPRAY RING
APU
APU
ABOO/6350

APU Fire Extinguishing Diagram
Figure 6

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FLIGHT CONTROL

General

Flight control is primarily by aileron, rudder and elevator surfaces, augmented by a variable-incidence tailplane, flaps, spoiler/speedbrakes and lift dumpers.

All surfaces are hydraulically operated, except the ailerons which react aerodynamically to movement of manually operated servo tabs. The control systems are duplicated so that no single failure will result in loss of control about any axis.

Hydraulic power is taken from the aircraft No.1 and No.2 systems, cut-off levers for which are on the centre console.

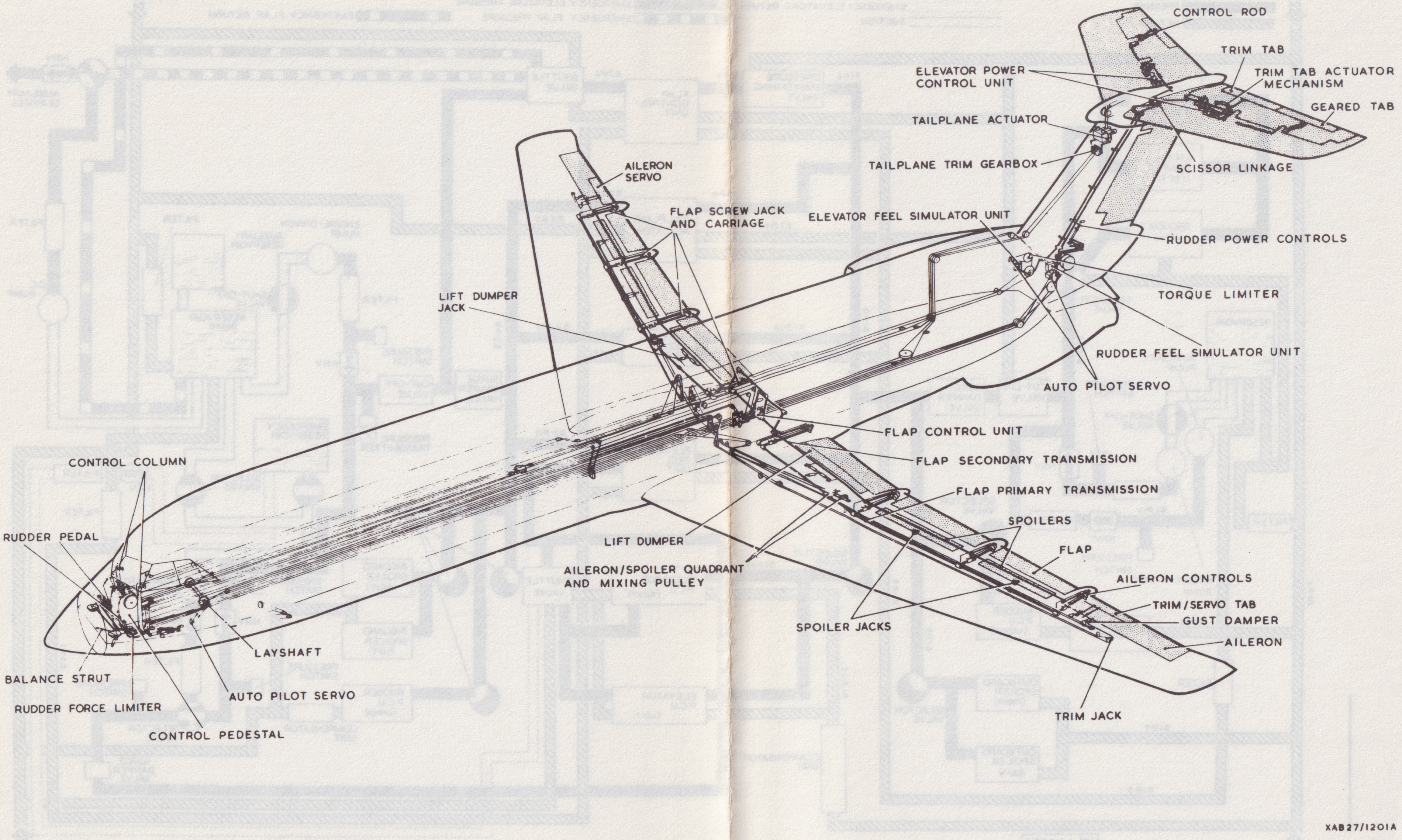
In the extreme emergency conditions of total hydraulic failure, the rudder and elevators can be manually operated.

Manual control of the three primary systems is from dual handwheels, rudder pedals and control columns; the pedals also control limited nosewheel steering.

The flight control systems are integrated with stall protection and configuration warning, and include gust damping features.

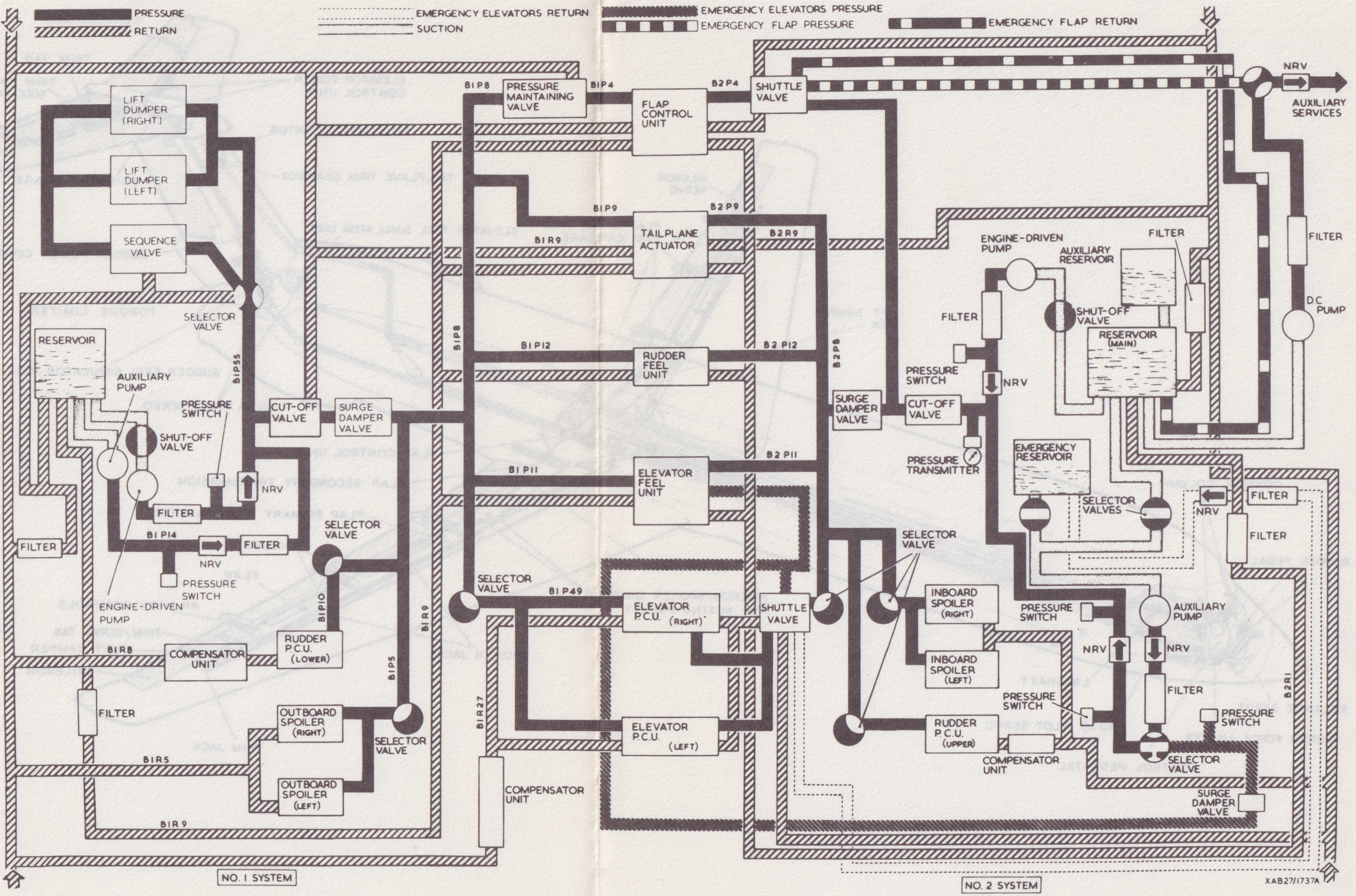
Feel simulation is employed in the rudder and elevator systems.

CONTROL LOCKS are not fitted, these being unnecessary because the rudder and elevator surfaces are adequately protected by the hydraulic lock formed within their respective power control units. The ailerons are protected by gust damper units which can absorb gust loads of up to 65 knots. The units function also as limit stops.


CONTROL ROD
TRIM TAB
ELEVATOR POWER CONTROL UNIT
TRIM TAB ACTUATOR MECHANISM
GEARED TAB
TAILPLANE ACTUATOR
TAILPLANE TRIM GEARBOX
SCISSOR LINKAGE
AILERON SERVO
FLAP SCREW JACK AND CARRIAGE
ELEVATOR FEEL SIMULATOR UNIT
RUDDER POWER CONTROLS
LIFT DUMPER JACK
TORQUE LIMITER
RUDDER FEEL SIMULATOR UNIT
AUTO PILOT SERVO
FLAP CONTROL UNIT
FLAP SECONDARY TRANSMISSION
CONTROL COLUMN
FLAP PRIMARY TRANSMISSION
SPOILERS
RUDDER PEDAL
LIFT DUMPER
FLAP
AILERON/SPOILER QUADRANT AND MIXING PULLEY
AILERON CONTROLS
TRIM/SERVO TAB
GUST DAMPER
SPOILER JACKS
AILERON
LAYSHAFT
BALANCE STRUT
AUTO PILOT SERVO
RUDDER FORCE LIMITER
TRIM JACK
CONTROL PEDESTAL
XAB27/1201A

Arrangement of Flight Controls
Figure 1

B070076


PRESSURE
RETURN
EMERGENCY ELEVATORS RETURN
SUCTION
EMERGENCY ELEVATORS PRESSURE
EMERGENCY FLAP PRESSURE
EMERGENCY FLAP RETURN
LIFT DUMPER (RIGHT)
LIFT DUMPER (LEFT)
SEQUENCE VALVE
SELECTOR VALVE
RESERVOIR
AUXILIARY PUMP
PRESSURE SWITCH
SHUT-OFF VALVE
NRV
FILTER
B1P14
NRV
FILTER
PRESSURE SWITCH
ENGINE-DRIVEN PUMP
FILTER
B1R1
B1R8
COMPENSATOR UNIT
RUDDER P.C.U. (LOWER)
B1P10
SELECTOR VALVE
FILTER
B1P55
CUT-OFF VALVE
SURGE DAMPER VALVE
B1R9
B1P5
OUTBOARD SPOILER (RIGHT)
OUTBOARD SPOILER (LEFT)
SELECTOR VALVE
B1R5
B1R9
NO. 1 SYSTEM
B1P8
PRESSURE MAINTAINING VALVE
B1P4
FLAP CONTROL UNIT
B2P4
SHUTTLE VALVE
B1P9
B2P9
TAILPLANE ACTUATOR
B1R9
B2R9
B1P8
B1P12
B2P12
RUDDER FEEL UNIT
B2P8
B1P11
B2P11
ELEVATOR FEEL UNIT
SELECTOR VALVE
B1P49
B1R27
ELEVATOR P.C.U. (RIGHT)
ELEVATOR P.C.U. (LEFT)
COMPENSATOR UNIT
SHUTTLE VALVE
SELECTOR VALVE
SURGE DAMPER VALVE
CUT-OFF VALVE
PRESSURE SWITCH
PRESSURE TRANSMITTER
FILTER
NRV
ENGINE-DRIVEN PUMP
AUXILIARY RESERVOIR
SHUT-OFF VALVE
RESERVOIR (MAIN)
FILTER
EMERGENCY RESERVOIR
SELECTOR VALVES
INBOARD SPOILER (RIGHT)
INBOARD SPOILER (LEFT)
RUDDER P.C.U. (UPPER)
COMPENSATOR UNIT
PRESSURE SWITCH
AUXILIARY PUMP
NRV
NRV
FILTER
PRESSURE SWITCH
PRESSURE SWITCH
SELECTOR VALVE
SURGE DAMPER VALVE
NRV
FILTER
FILTER
B2R1
NRV
AUXILIARY SERVICES
FILTER
D.C PUMP
NO. 2 SYSTEM
XAB27/1737A

Hydraulic System Diagram
Figure 2

D082136

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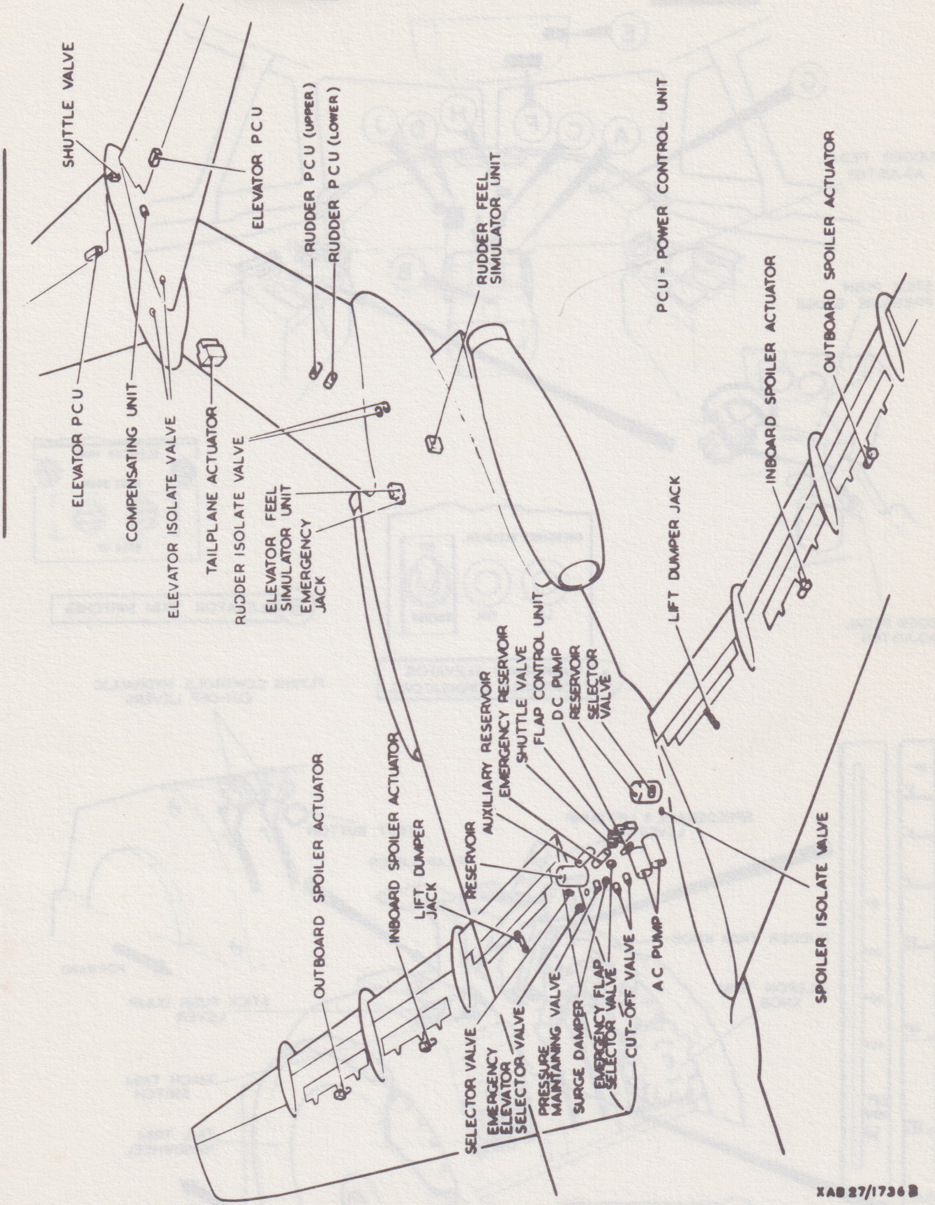
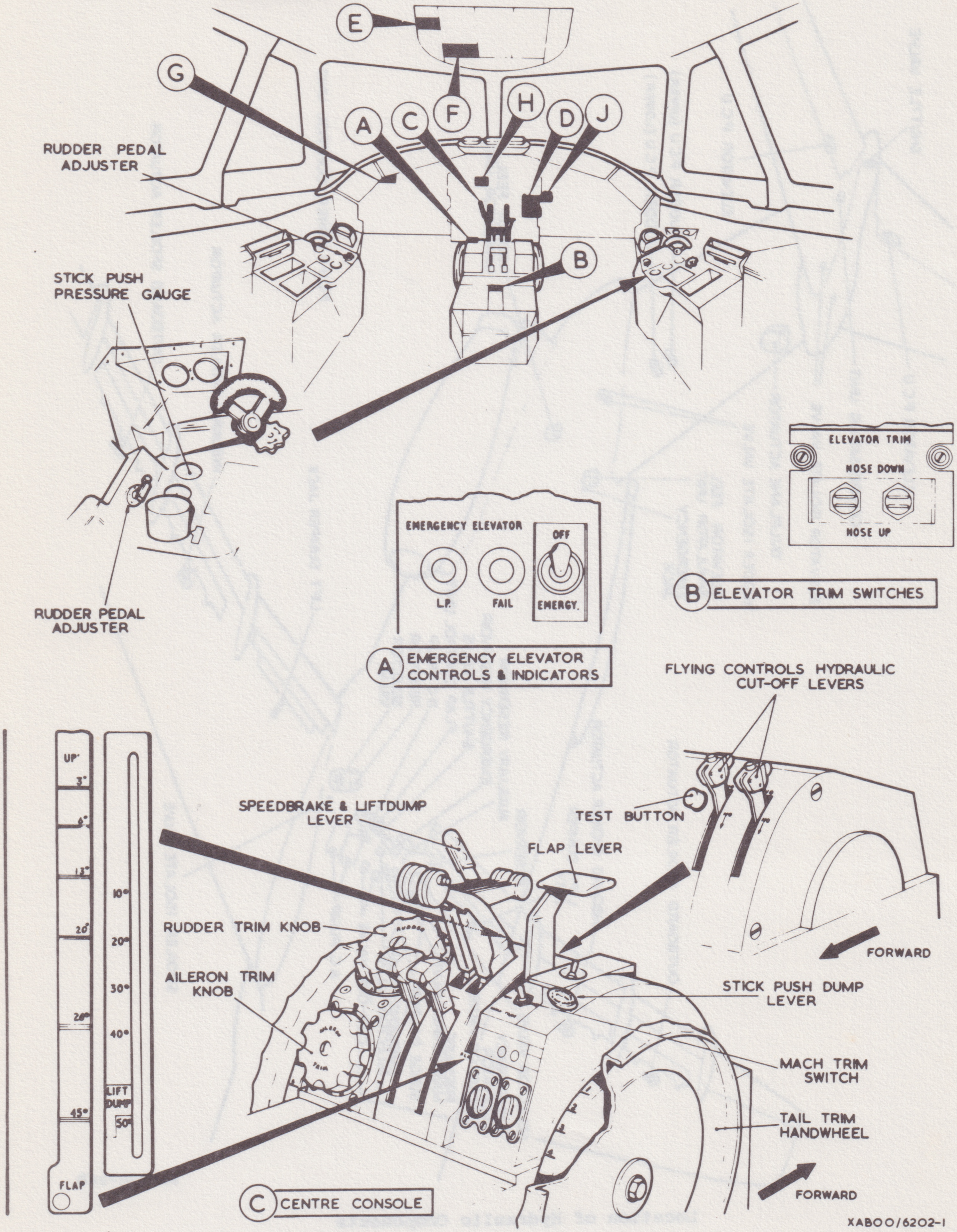
X027184


SHUTTLE VALVE
ELEVATOR P C U
RUDDER P C U (UPPER)
RUDDER P C U (LOWER)
RUDDER FEEL SIMULATOR UNIT
P C U = POWER CONTROL UNIT
ELEVATOR P C U
COMPENSATING UNIT
ELEVATOR ISOLATE VALVE
TAILPLANE ACTUATOR
RUDDER ISOLATE VALVE
ELEVATOR FEEL SIMULATOR UNIT
EMERGENCY JACK
LIFT DUMPER JACK
INBOARD SPOILER ACTUATOR
OUTBOARD SPOILER ACTUATOR
OUTBOARD SPOILER ACTUATOR
INBOARD SPOILER ACTUATOR
LIFT DUMPER JACK
RESERVOIR
AUXILIARY RESERVOIR
EMERGENCY RESERVOIR
SHUTTLE VALVE
FLAP CONTROL UNIT
D C PUMP
RESERVOIR
SELECTOR VALVE
SPOILER ISOLATE VALVE
SELECTOR VALVE
EMERGENCY ELEVATOR SELECTOR VALVE
PRESSURE MAINTAINING VALVE
SURGE DAMPER
EMERGENCY FLAP SELECTOR VALVE
CUT-OFF VALVE
A C PUMP

XAB 27/1736 B

Location of Hydraulic Components
Figure 3


E
G
A
C
F
H
D
J
RUDDER PEDAL ADJUSTER
B
STICK PUSH PRESSURE GAUGE
RUDDER PEDAL ADJUSTER
EMERGENCY ELEVATOR
OFF
L.P.
FAIL
EMERGY.
A EMERGENCY ELEVATOR CONTROLS & INDICATORS
ELEVATOR TRIM
NOSE DOWN
NOSE UP
B ELEVATOR TRIM SWITCHES
FLYING CONTROLS HYDRAULIC CUT-OFF LEVERS
TEST BUTTON
SPEEDBRAKE & LIFTDUMP LEVER
FLAP LEVER
RUDDER TRIM KNOB
AILERON TRIM KNOB
FORWARD
STICK PUSH DUMP LEVER
MACH TRIM SWITCH
TAIL TRIM HANDWHEEL
FORWARD
UP
3°
6°
13°
20°
26°
45°
FLAP
10°
20°
30°
40°
LIFT DUMP
50°
C CENTRE CONSOLE
XABOO/6202-1

Typical Controls and Indicators (1) -
(See also Figure 5)
Figure 4

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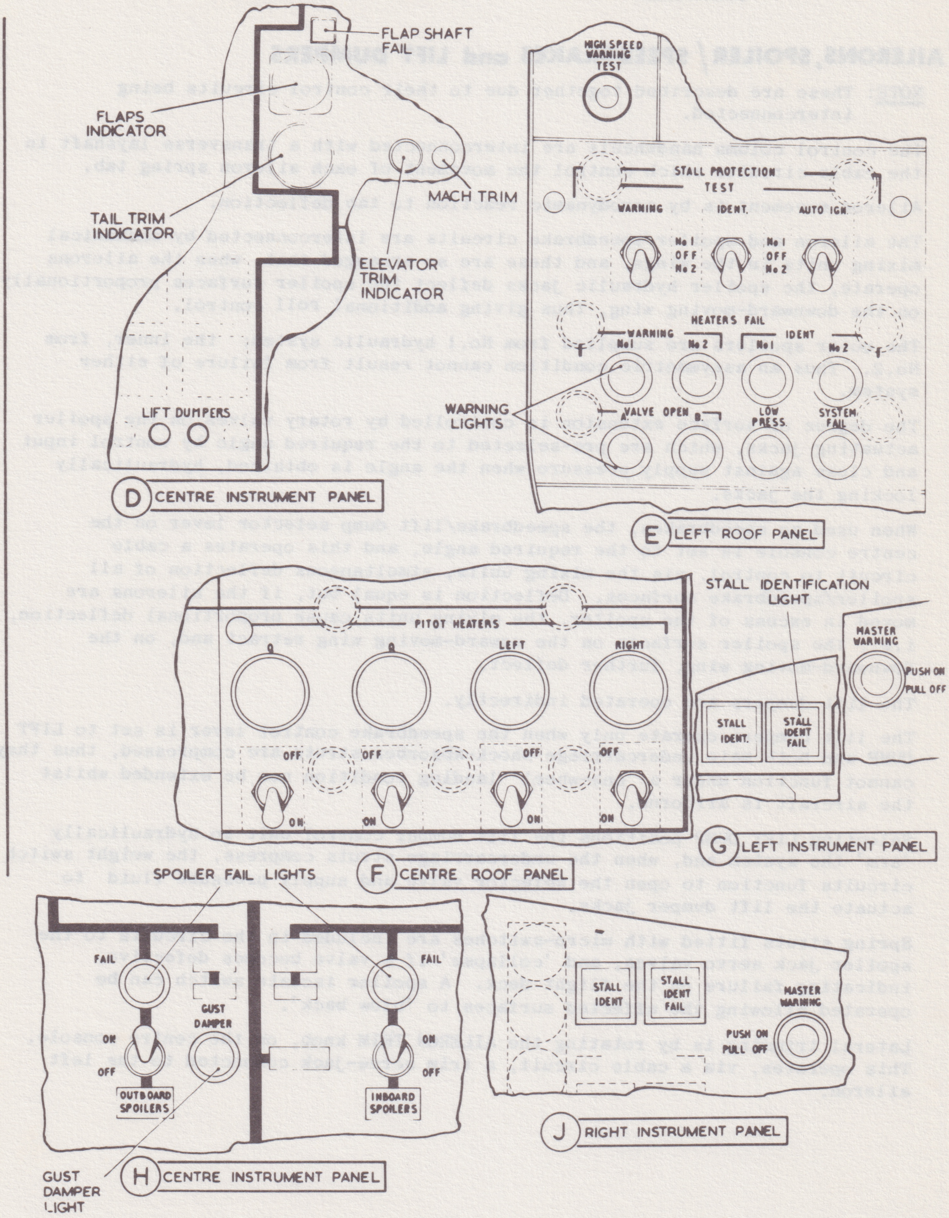
FLAP SHAFT FAIL
FLAPS INDICATOR
MACH TRIM
TAIL TRIM INDICATOR
ELEVATOR TRIM INDICATOR
LIFT DUMPERS
D CENTRE INSTRUMENT PANEL
HIGH SPEED WARNING TEST
STALL PROTECTION TEST
WARNING
IDENT.
AUTO IGN.
No 1 OFF No 2
No 1 OFF No 2
HEATERS FAIL
WARNING
IDENT
No 1
No 2
No 1
No 2
WARNING LIGHTS
VALVE OPEN
LOW PRESS.
SYSTEM FAIL
E LEFT ROOF PANEL
STALL IDENTIFICATION LIGHT
PITOT HEATERS
LEFT
RIGHT
OFF
OFF
OFF
OFF
ON
ON
ON
ON
MASTER WARNING
PUSH ON PULL OFF
STALL IDENT.
STALL IDENT FAIL
G LEFT INSTRUMENT PANEL
F CENTRE ROOF PANEL
SPOILER FAIL LIGHTS
FAIL
FAIL
GUST DAMPER
ON
OFF
ON
OFF
OUTBOARD SPOILERS
INBOARD SPOILERS
GUST DAMPER LIGHT
H CENTRE INSTRUMENT PANEL
STALL IDENT
STALL IDENT FAIL
MASTER WARNING
PUSH ON PULL OFF
J RIGHT INSTRUMENT PANEL
XABOO/6202-2

Typical Controls and Indicators (2) -
(See also Figure 4)
Figure 5

AILERONS, SPOILER / SPEEDBRAKES and LIFT DUMPERS

NOTE: These are described together due to their control circuits being interconnected.

The control column handwheels are interconnected with a transverse layshaft in the cable circuits which control the movement of each aileron spring tab.

Aileron movement is by aerodynamic reaction to tab deflection.

The aileron and spoiler/speedbrake circuits are interconnected by mechanical mixing units in the wings, and these are so arranged that, when the ailerons operate, the spoiler hydraulic jacks deflect the spoiler surfaces proportionally on the downward-moving wing, thus giving additional roll control.

The outer spoilers are supplied from No.1 hydraulic system; the inner, from No.2. Thus an assymmetric condition cannot result from failure of either system.

The degree of surface extension is controlled by rotary valves on the spoiler actuating jacks, which are pre-selected to the required angle by control input and close against supply pressure when the angle is obtained, hydraulically locking the jacks.

When used as speedbrakes, the speedbrake/lift dump selector lever on the centre console is set to the required angle, and this operates a cable circuit to control, via the mixing units, simultaneous deflection of all spoiler/speedbrake surfaces. Deflection is equal but, if the ailerons are moved in excess of the spoiler, the mixing units cause proportional deflection, i.e., the spoiler surfaces on the upward-moving wing retract and, on the downward-moving wing, further deflect.

The lift dumpers are operated indirectly.

The lift dumpers operate only when the speedbrake control lever is set to LIFT DUMP and both main undercarriage shock-absorber struts are compressed, thus they cannot function under a 'one-wheel' landing condition nor be extended whilst the aircraft is airborne.

Selecting LIFT DUMP positions the lift dumper control unit to hydraulically 'arm' the system and, when the undercarriage struts compress, the weight switch circuits function to open the selector valve and supply pressure fluid to actuate the lift dumper jacks.

Spring struts fitted with micro-switches are included in the circuits to the spoiler jack servo valves, and 'collapse' if a valve becomes defective, indicating failure on the flight deck. A spoiler isolate switch can be operated allowing the affected surfaces to 'blow back'.

Lateral trimming is by rotating the AILERON TRIM knob, on the centre console. This operates, via a cable circuit, a trim screw-jack connected to the left aileron.

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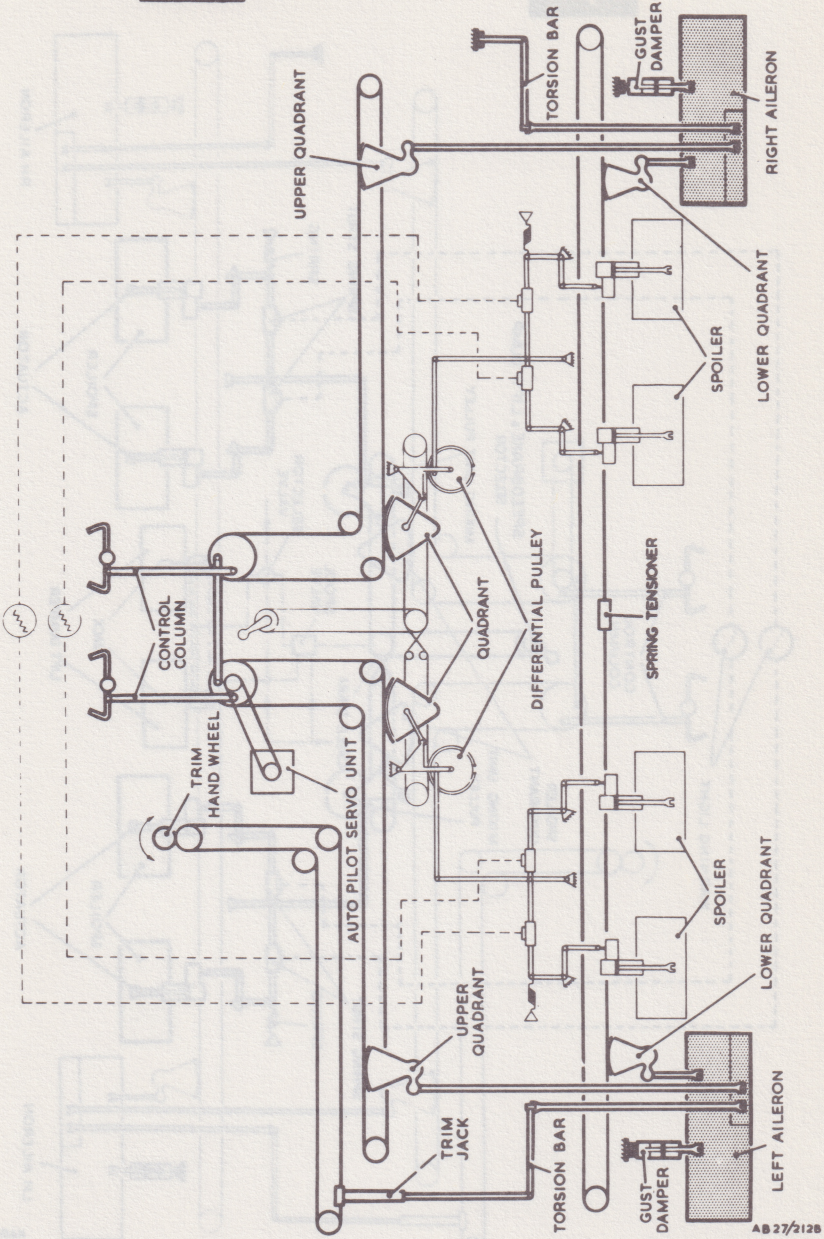
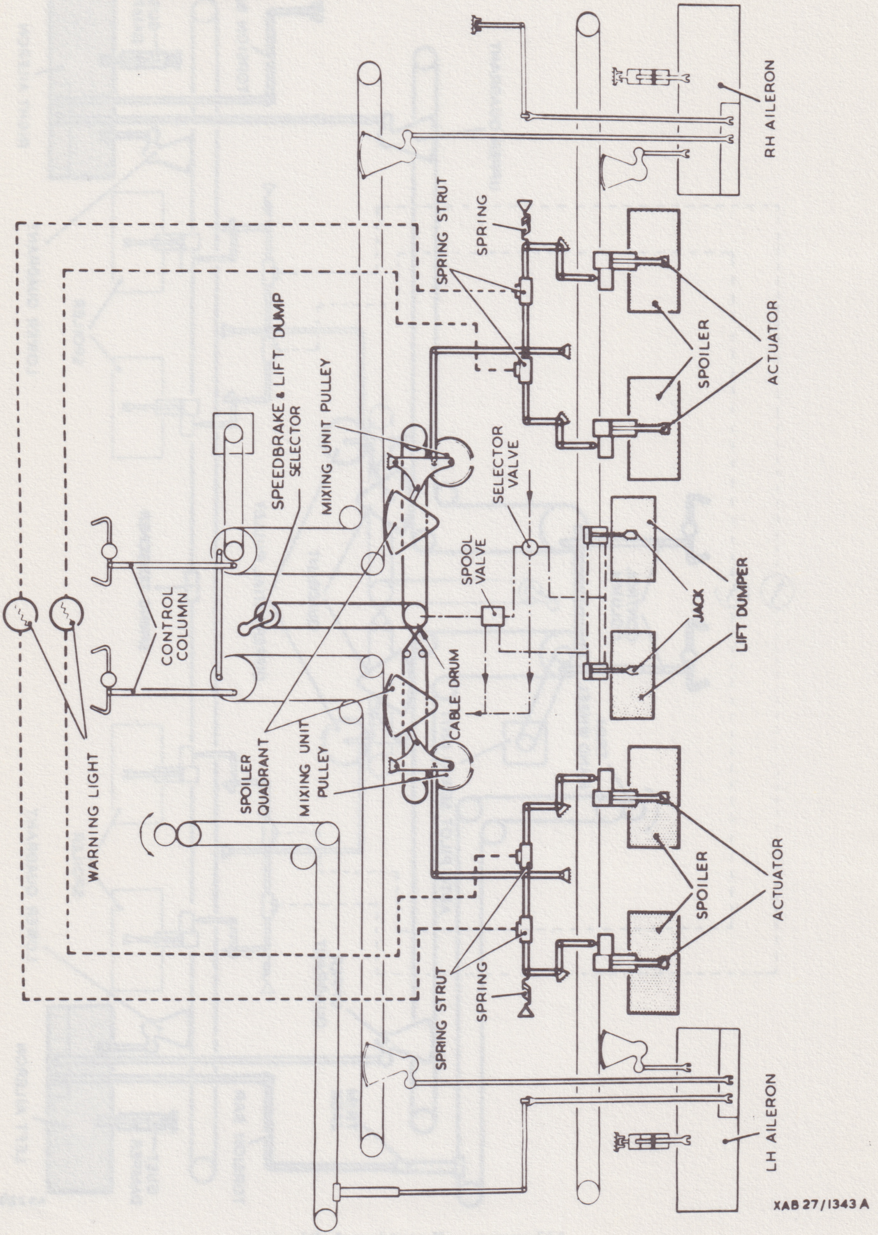

UPPER QUADRANT
TORSION BAR
GUST DAMPER
RIGHT AILERON
LOWER QUADRANT
SPOILER
CONTROL COLUMN
QUADRANT
DIFFERENTIAL PULLEY
SPRING TENSIONER
TRIM HAND WHEEL
AUTO PILOT SERVO UNIT
SPOILER
LOWER QUADRANT
UPPER QUADRANT
TRIM JACK
TORSION BAR
GUST DAMPER
LEFT AILERON
AB 27/2128

Ailerons - Functional Diagram
Figure 6


RH AILERON
SPRING STRUT
SPRING
SPOILER
ACTUATOR
SPEEDBRAKE & LIFT DUMP SELECTOR
MIXING UNIT PULLEY
SELECTOR VALVE
SPOOL VALVE
CONTROL COLUMN
JACK
LIFT DUMPER
CABLE DRUM
WARNING LIGHT
SPOILER QUADRANT
MIXING UNIT PULLEY
SPOILER
ACTUATOR
SPRING STRUT
SPRING
LH AILERON
XAB 27/1343 A

B082190

Functional Diagram - Spoilers/Speedbrakes and Lift Dumpers
Figure 7

RUDDER

Dual sets of parallel-acting pedals control, via cable circuits, twin hydraulic power control units (PCUs) to move the single rudder surface. The PCUs are independent, and supplied by separate (No.1 and No.2) hydraulic systems. A force limiter unit, beneath the flight deck, prevents damaging forces being transmitted to the PCU servo valves. Micro-switches, on the valves, indicate a PCU failure, should it occur.

In the event of both hydraulic systems failing, the rudder can be moved manually, due to direct mechanical linkage of the servo valve operating rods, but a small degree of lost movement occurs before the rods reach end-of-travel and react against the PCU. 'Feel' simulation is provided by a feel unit utilizing two hydraulic jacks, which are independent and supplied from separate (No.1 and No.2) systems.

The rudder has no trim tab but is itself offset to effect directional trim, by rotating the RUDDER TRIM knob, on the centre console. This operates a cable connected to the rudder feel unit mechanism, displacing its datum to impart the required angular bias.

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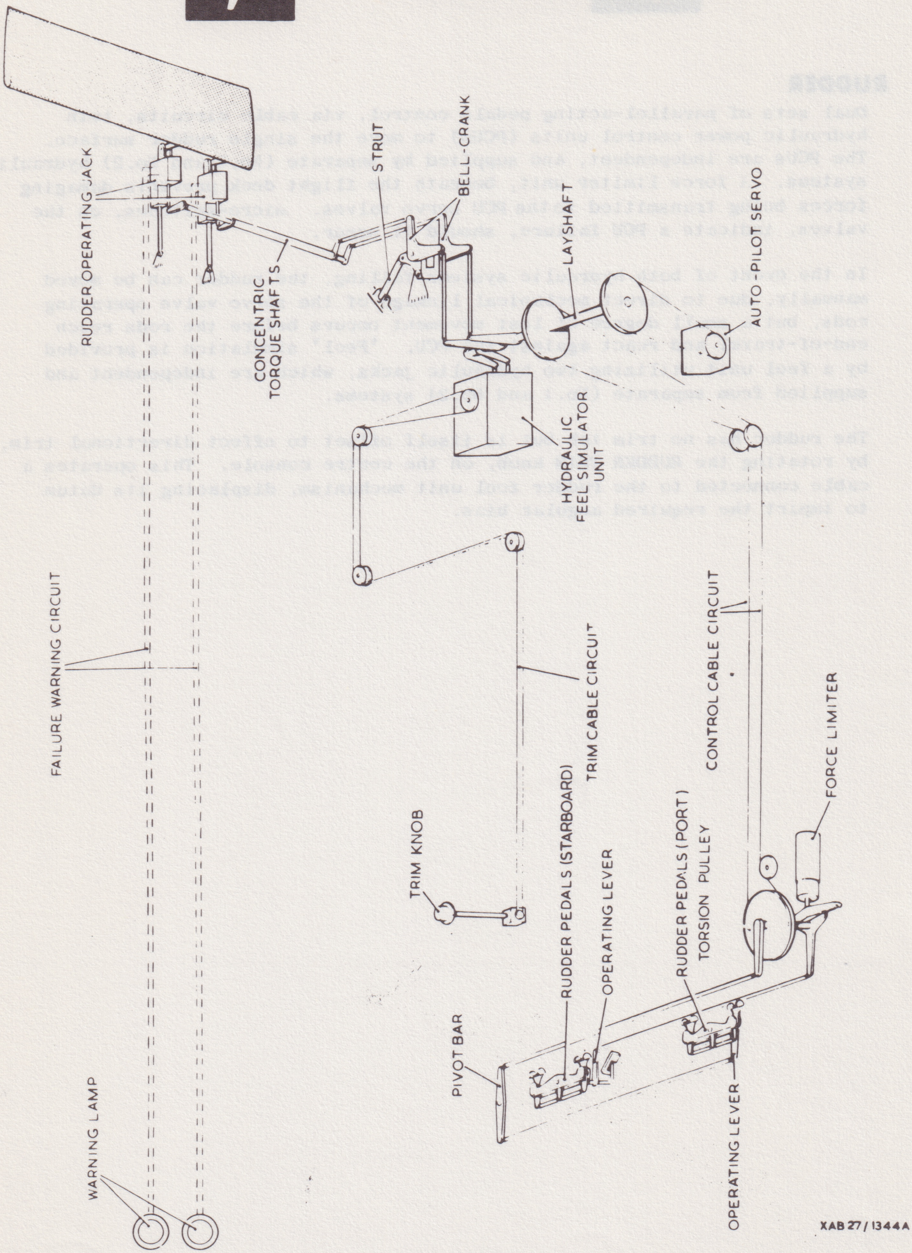
RUDDER OPERATING JACK
CONCENTRIC TORQUE SHAFTS
STRUT
BELL-CRANK
LAYSHAFT
AUTO PILOT SERVO
HYDRAULIC FEEL SIMULATOR UNIT
FAILURE WARNING CIRCUIT
TRIM CABLE CIRCUIT
CONTROL CABLE CIRCUIT
FORCE LIMITER
TRIM KNOB
RUDDER PEDALS (STARBOARD)
OPERATING LEVER
RUDDER PEDALS (PORT)
TORSION PULLEY
PIVOT BAR
WARNING LAMP
OPERATING LEVER
XAB 27/1344A

BC70-33

Rudder - Functional Diagram
Figure 8

ELEVATORS

Dual control columns transmit control movement, via duplicate cables, push-pull rods and PCUs to move the two elevator surfaces.

The PCUs, one in each elevator, are identical tandem-ram units with one ram of each supplied by No.1 hydraulic system, their opposing rams being supplied by No.2 system.

Elevator 'runaway' is prevented by one half of each PCU opposing the other half.

Included in the elevator control system are a spring strut, stall warning stick pusher unit, 'feel' simulator and a torque limiter.

The spring strut resists rearward movement of the control columns sufficiently to avoid a violent input to the PCU servo valves; the torque limiter similarly protects the valves when under auto-pilot control. Should a PCU failure occur, this is indicated on the flight deck by micro-switched lights.

The feel simulator unit utilizes two hydraulic jacks, which are independent and supplied from separate (No.1 and No.2) systems.

The stick pusher is a pneumatic unit and normally remains inactive; it interrupts the control system to push the control columns forward, when automatically pressurized by the stall (ident) system.

In the event of both hydraulic systems failed, an emergency supply can be selected from an auxiliary reservoir. This is pressurized by No.2 a.c. pump, and supplies direct to the feel unit and PCUs.

In the remote case of total hydraulic failure, the elevators can be manually operated; they have geared tabs and are mass-balanced to assist this.

An electrically-actuated trim tab is fitted to the left elevator and can be used as an alternative to tailplane trim in manual flight.

Auto-pilot control is by servo motor, linked to the right-hand control circuit.

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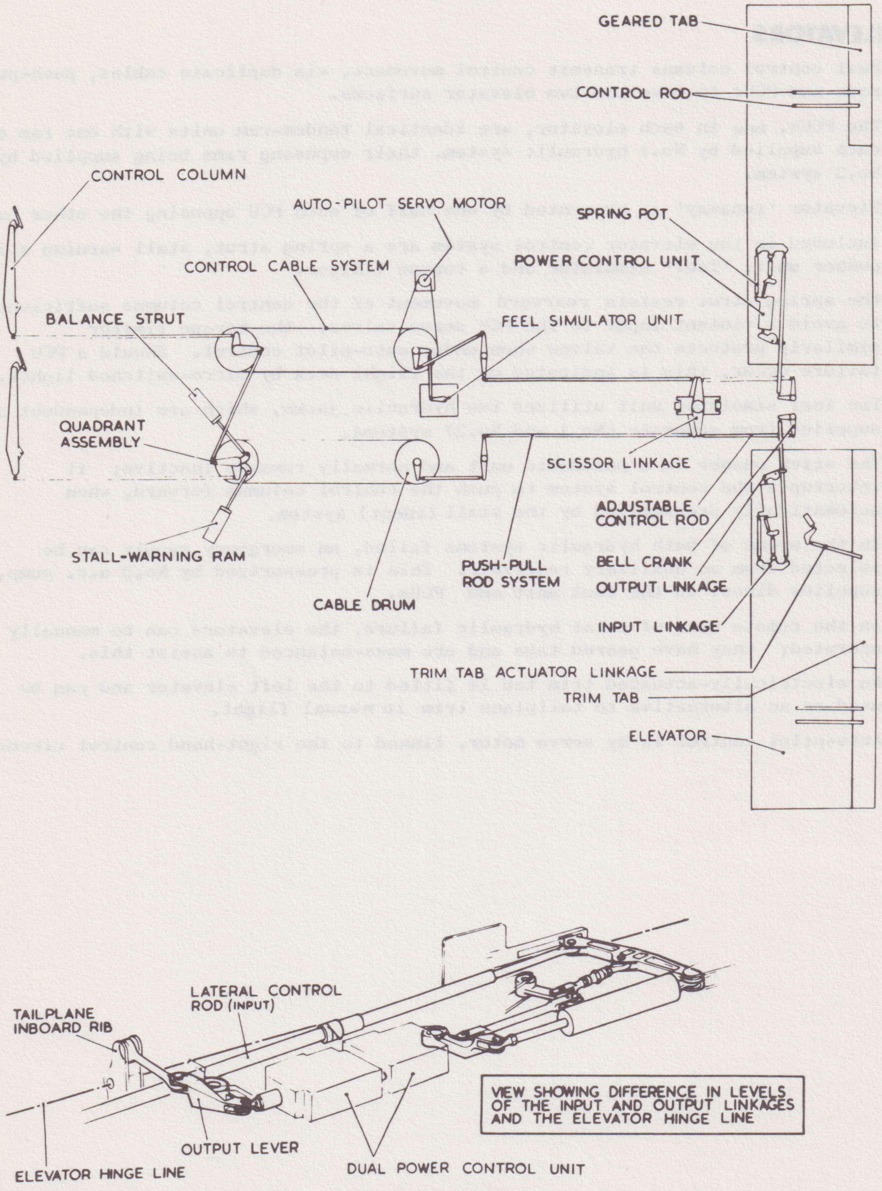

GEARED TAB
CONTROL ROD
CONTROL COLUMN
AUTO-PILOT SERVO MOTOR
SPRING POT
CONTROL CABLE SYSTEM
POWER CONTROL UNIT
BALANCE STRUT
FEEL SIMULATOR UNIT
QUADRANT ASSEMBLY
SCISSOR LINKAGE
ADJUSTABLE CONTROL ROD
STALL-WARNING RAM
PUSH-PULL ROD SYSTEM
BELL CRANK
OUTPUT LINKAGE
CABLE DRUM
INPUT LINKAGE
TRIM TAB ACTUATOR LINKAGE
TRIM TAB
ELEVATOR
LATERAL CONTROL ROD (INPUT)
TAILPLANE INBOARD RIB
VIEW SHOWING DIFFERENCE IN LEVELS OF THE INPUT AND OUTPUT LINKAGES AND THE ELEVATOR HINGE LINE
OUTPUT LEVER
ELEVATOR HINGE LINE
DUAL POWER CONTROL UNIT

XAB27/1275

Elevators - Functional Diagram

Figure 9

TAILPLANE

Dual handwheels control,via a clutch and cable circuit, the tailplane trim gearbox.

A duplicated input linkage connects the gearbox with the servo valves of twin hydraulic motors, which drive the actuator screw to move the tailplane.

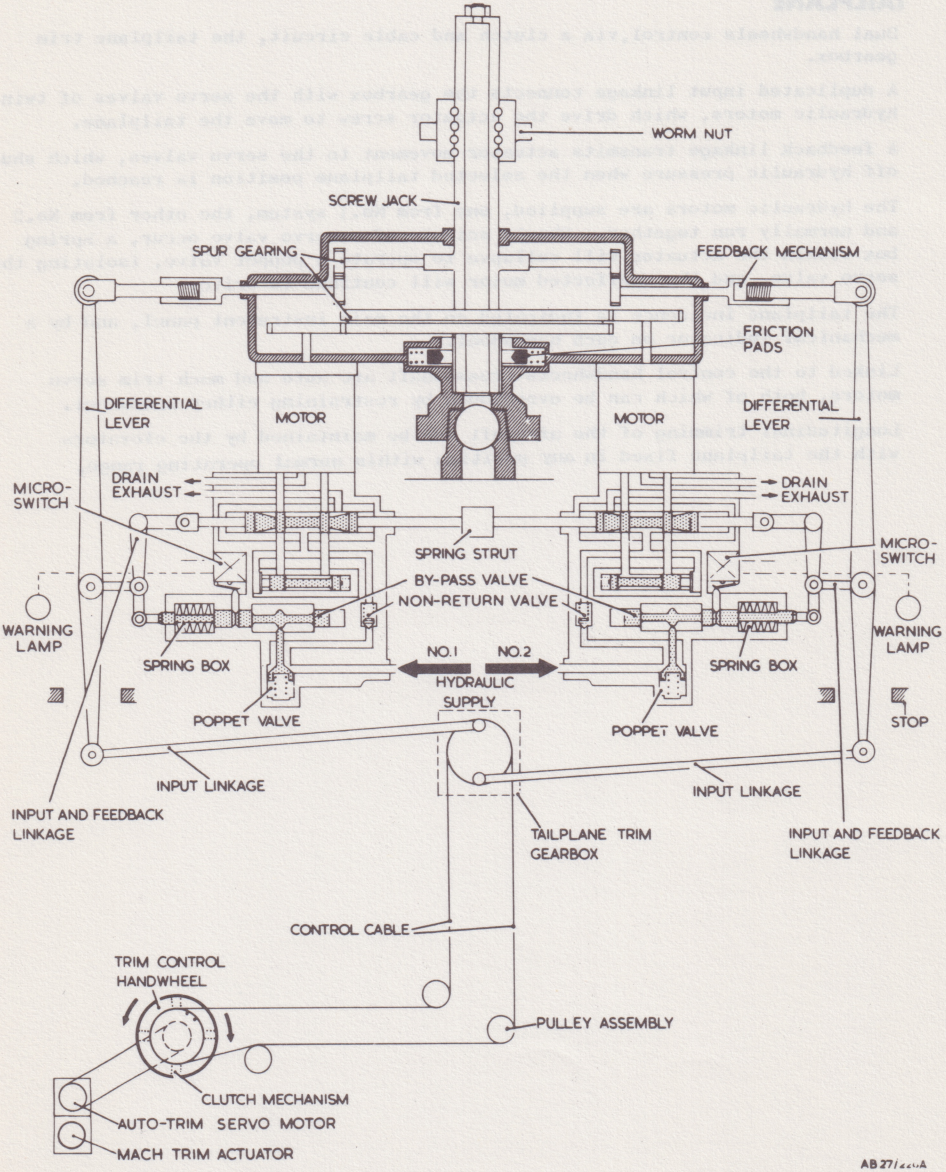
A feedback linkage transmits actuator movement to the servo valves, which shut off hydraulic pressure when the selected tailplane position is reached.

The hydraulic motors are supplied, one from No.1 system, the other from No.2 and normally run together. Should seizure of a servo valve occur, a spring box within the actuator will collapse to operate a poppet valve, isolating the servo valve, and the unaffected motor will continue to drive.

The tailplane incidence is indicated on the main instrument panel, and by a mechanical indicator on each handwheel.

Linked to the control handwheels cross-shaft are auto and mach trim servo motors, both of which can be overridden by restraining either handwheel.

Longitudinal trimming of the aircraft can be maintained by the elevators with the tailplane fixed in any position within normal operating range,


WORM NUT
SCREW JACK
SPUR GEARING
FEEDBACK MECHANISM
FRICTION PADS
DIFFERENTIAL LEVER
MOTOR
MOTOR
DIFFERENTIAL LEVER
MICRO-SWITCH
DRAIN
EXHAUST
DRAIN
EXHAUST
MICRO-SWITCH
SPRING STRUT
BY-PASS VALVE
NON-RETURN VALVE
WARNING LAMP
WARNING LAMP
SPRING BOX
SPRING BOX
NO.1
NO.2
HYDRAULIC SUPPLY
POPPET VALVE
POPPET VALVE
STOP
INPUT LINKAGE
INPUT LINKAGE
INPUT AND FEEDBACK LINKAGE
INPUT AND FEEDBACK LINKAGE
TAILPLANE TRIM GEARBOX
CONTROL CABLE
TRIM CONTROL HANDWHEEL
PULLEY ASSEMBLY
CLUTCH MECHANISM
AUTO-TRIM SERVO MOTOR
MACH TRIM ACTUATOR
AB 27/226A

Tailplane - Functional Diagram
Figure 10

FLAPS

A single, gated selector lever controls, via a rod and cable circuit, the flap signalling mechanism which transmits control movement to the flap control unit. This operates valves controlling twin hydraulic motors that drive the torque shaft/screwjack system to extend or retract the six Fowler-type surfaces.

The motors are supplied, one from each of Nos.1 and 2 systems.

A backlash dog coupling, between the two torque shaft systems, provides that the secondary system normally runs off load, and takes up load only in the event of a primary shaft failure.

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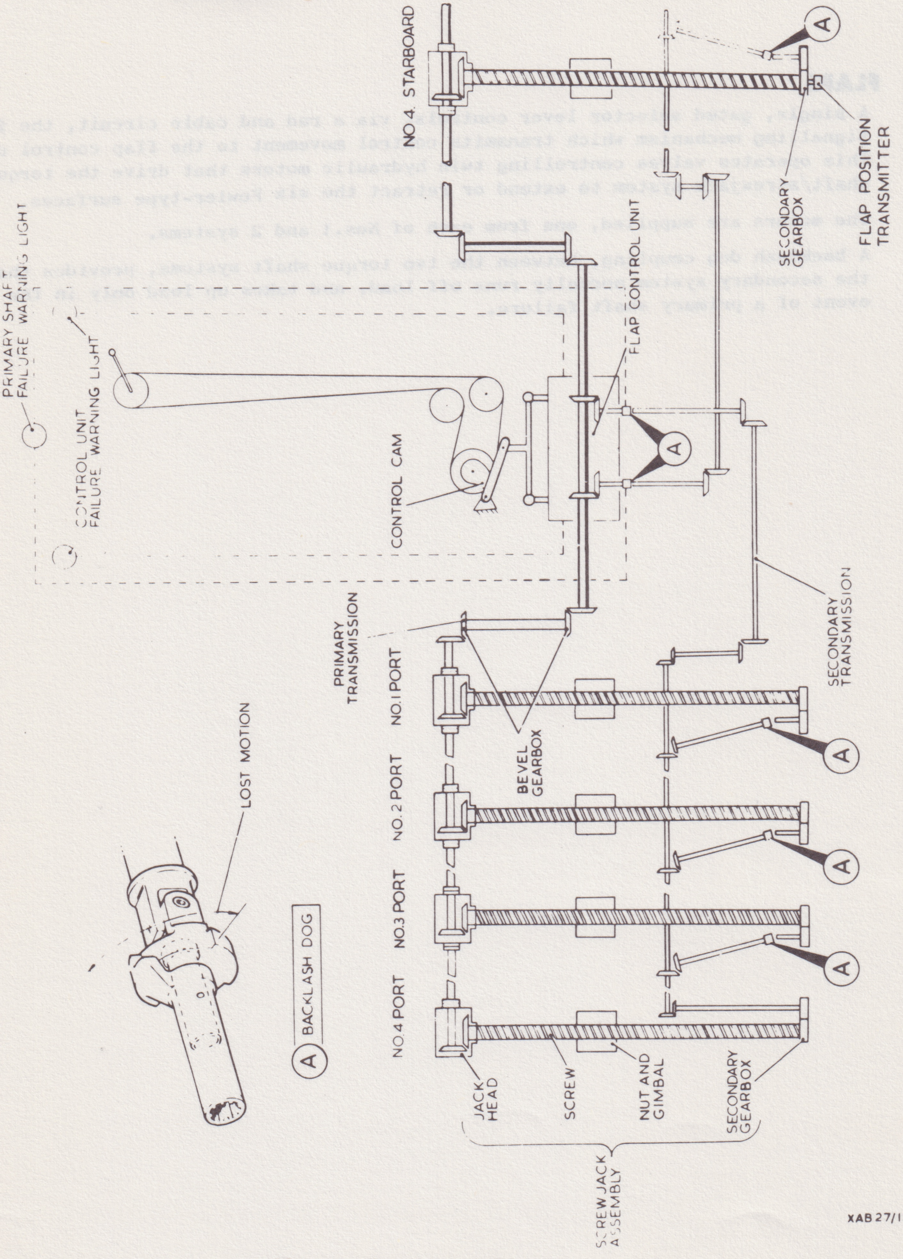
NO.4 STARBOARD
FLAP POSITION TRANSMITTER
SECONDARY GEARBOX
FLAP CONTROL UNIT
PRIMARY SHAFT FAILURE WARNING LIGHT
CONTROL UNIT FAILURE WARNING LIGHT
CONTROL CAM
PRIMARY TRANSMISSION
BEVEL GEARBOX
SECONDARY TRANSMISSION
NO.1 PORT
NO.2 PORT
NO.3 PORT
NO.4 PORT
A
BACKLASH DOG
LOST MOTION
JACK HEAD
SCREW
NUT AND GIMBAL
SECONDARY GEARBOX
SCREW JACK ASSEMBLY

XAB27/1342A

Flaps - Functional Diagram
Figure 11

STALL PROTECTION

This comprises three sub-systems; auto-ignition, stall warning (stick-shake) and stall recognition (stick-push).

The system duplicates signals which operate the auto-ignition, stick-shakers and arm the horns. Signals to the stall recognition circuits are also duplicated up to a signal priority selector circuit.

On the approach to a stall condition, the auto-ignition circuits operate first and then, at an angle of incidence which is advanced by an accelerated stall condition, both stick-shakers operate and continue to do so until the angle of incidence has been reduced below the operating value. Simultaneously with the stick-shakers operation, the horns are armed and a stall warning slave relay of the pneumatic system energized.

If the angle of incidence increases to an angle greater than the stall warning angle, or the stall condition accelerated, the signals from both stall recognition sensors travel via their respective signal summing units to complete the horn circuits, causing both horns to sound and energizing a recognition slave relay. The circuits in both slave relay units now being complete, the signals pass to valves A and B, opening the valves and releasing nitrogen to operate the stick-push ram; this moves the control columns sharply forward and induces a nose-down pitching movement. Both A and B VALVE OPEN red lights on the roof panel will come on, also the amber STALL IDENT (Stick Push) lights on the instrument panel. With a return to normal flight, all stall warning and recognition lights will go out and the stick-pusher, horns and stick-shakers will stop operating.

Two timing relays, in conjunction with undercarriage relays, prevent operation of the stick-push SSU accelerated-action (rate) circuits for five seconds after take-off, when the somewhat abrupt change of aircraft attitude might otherwise induce unwanted stick-push action. Undercarriage relays also inhibit sensor actuation of the three stall protection sub-systems whilst the aircraft is on the ground.

Two switches on the roof panel permit testing of the auto-ignition and stick-shake sub-systems at all times, but a third, stick-push, test-switch only becomes effective whilst the aircraft is on the ground.

It should be noted that whilst any combination of individual stall-warning SSU and stall-recognition SSU operation in the correct sequence, will produce stick-push action, both SSU's of a system must be operated to cause the associated horn to sound.

A red SYSTEM FAIL light on the roof panel comes on in the event of either:-

1. a malfunction of, or loss of power to, lock-out circuits associated with 2 and 3 below,
2. a stall recognition signal being given without a prior stall warning signal, or
3. a stall warning system being energized but not followed within 60 sec. by a stall recognition signal, or
4. operation of the dump valve lever.

A red LOW PRESS light on the roof panel comes on if the pressure in the low pressure accumulator falls below 45 p.s.i. and goes out when the pressure rises above 48 p.s.i.

Except when the system is dumped, the red STALL IDENT FAIL (Pusher Fail)light on the instrument panel in front of each pilot repeats a system fail signal, and also energizes with a low pressure signal or with a valve stuck open.

A dump valve, operated by a STICK PUSH DUMP VALVE lever on the throttle pedestal allows ram pressure to be vented to atmosphere in the event of a failure in the system. As indicated above, this puts on the SYSTEM FAIL light on the roof panel, but cancels the red STALL IDENT FAIL (Pusher Fail)lights on the instrument panel in front of each pilot.

The sensors are heated for protection against icing and appropriate HEATERS FAIL lights on the STALL PROTECTION section of the roof panel will go on in the event of failure. Switches which control the heaters are also mounted on the roof panel.

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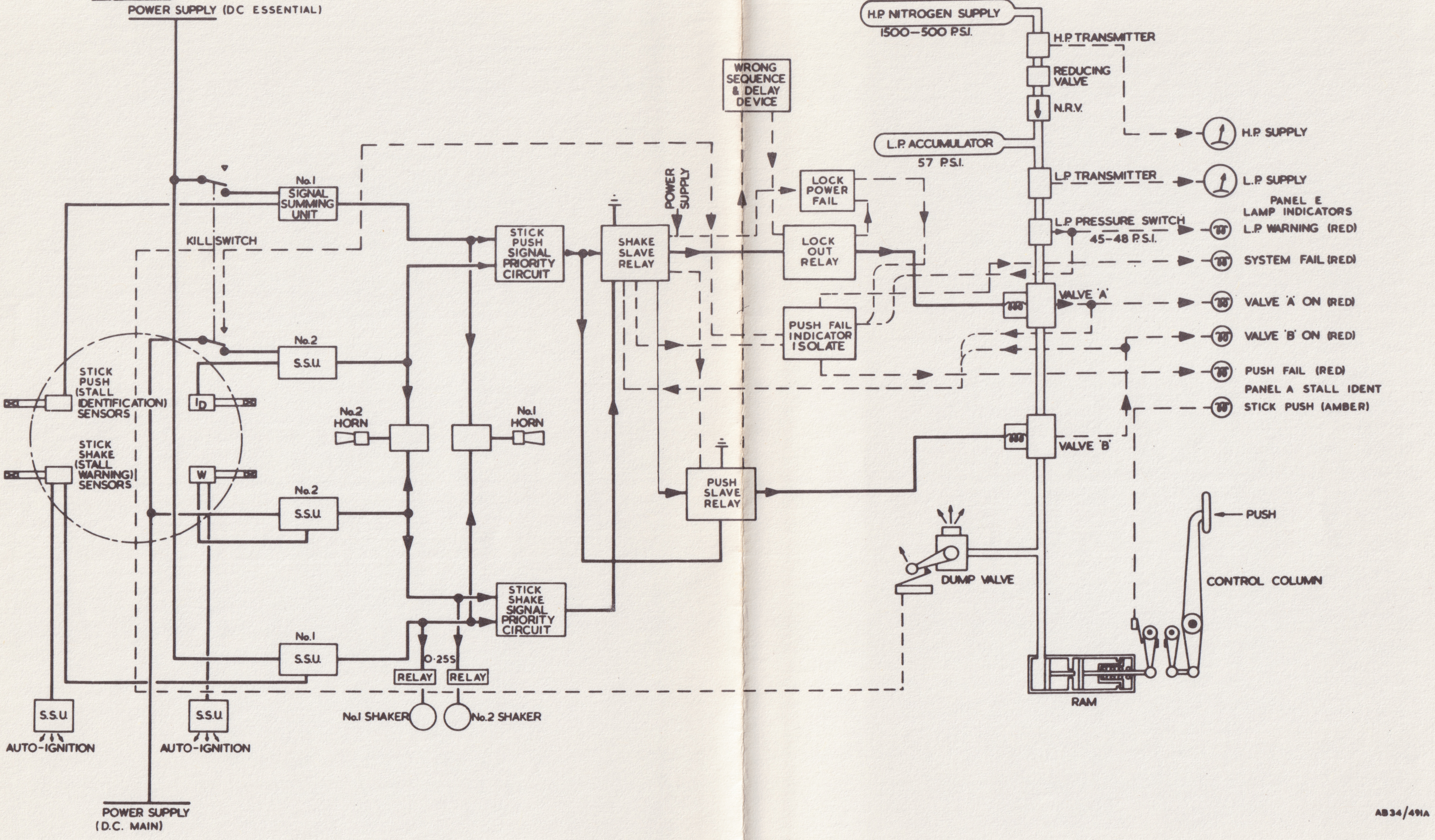
POWER SUPPLY (DC ESSENTIAL)
No.1 SIGNAL SUMMING UNIT
KILL SWITCH
STICK PUSH SIGNAL PRIORITY CIRCUIT
SHAKE SLAVE RELAY
POWER SUPPLY
WRONG SEQUENCE & DELAY DEVICE
LOCK POWER FAIL
LOCK OUT RELAY
PUSH FAIL INDICATOR ISOLATE
H.P. NITROGEN SUPPLY 1500—500 P.S.I.
H.P. TRANSMITTER
REDUCING VALVE
N.R.V.
L.P. ACCUMULATOR 57 P.S.I.
L.P. TRANSMITTER
L.P. PRESSURE SWITCH 45-48 P.S.I.
H.P. SUPPLY
L.P. SUPPLY
PANEL E LAMP INDICATORS
L.P. WARNING (RED)
SYSTEM FAIL (RED)
VALVE 'A'
VALVE 'A' ON (RED)
VALVE 'B' ON (RED)
PUSH FAIL (RED)
PANEL A STALL IDENT
STICK PUSH (AMBER)
VALVE 'B'
No.2 S.S.U.
STICK PUSH (STALL IDENTIFICATION) SENSORS
ID
No.2 HORN
No.1 HORN
STICK SHAKE (STALL WARNING) SENSORS
W
No.2 S.S.U.
PUSH SLAVE RELAY
PUSH
DUMP VALVE
CONTROL COLUMN
STICK SHAKE SIGNAL PRIORITY CIRCUIT
No.1 S.S.U.
0·25S
RELAY
RELAY
S.S.U.
AUTO-IGNITION
S.S.U.
AUTO-IGNITION
No.1 SHAKER
No.2 SHAKER
RAM
POWER SUPPLY (D.C. MAIN)
AB34/491A

Stall Protection Diagram
Figure 12

B070088

FLIGHT CONTROL - SERVICING

LUBRICATION

This should be carried out in accordance with the detailed charts contained in the aircraft Maintenance Manual.

WATER DRAINS

Operate the feel system pitot/static water drains (Fig.101) to release any accumulated water. See Figure 102 for Nitrogen System Water Drains.

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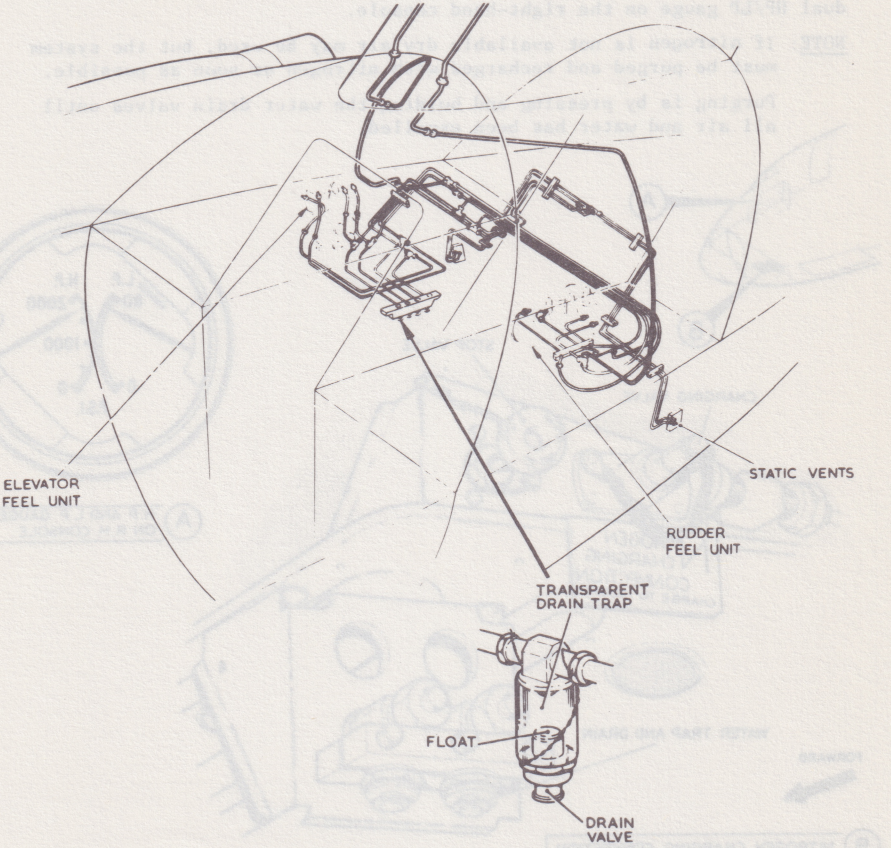

ELEVATOR
FEEL UNIT
STATIC VENTS
RUDDER
FEEL UNIT
TRANSPARENT
DRAIN TRAP
FLOAT
DRAIN
VALVE

Feel Simulation - Pitot/Static Drains
Figure 101

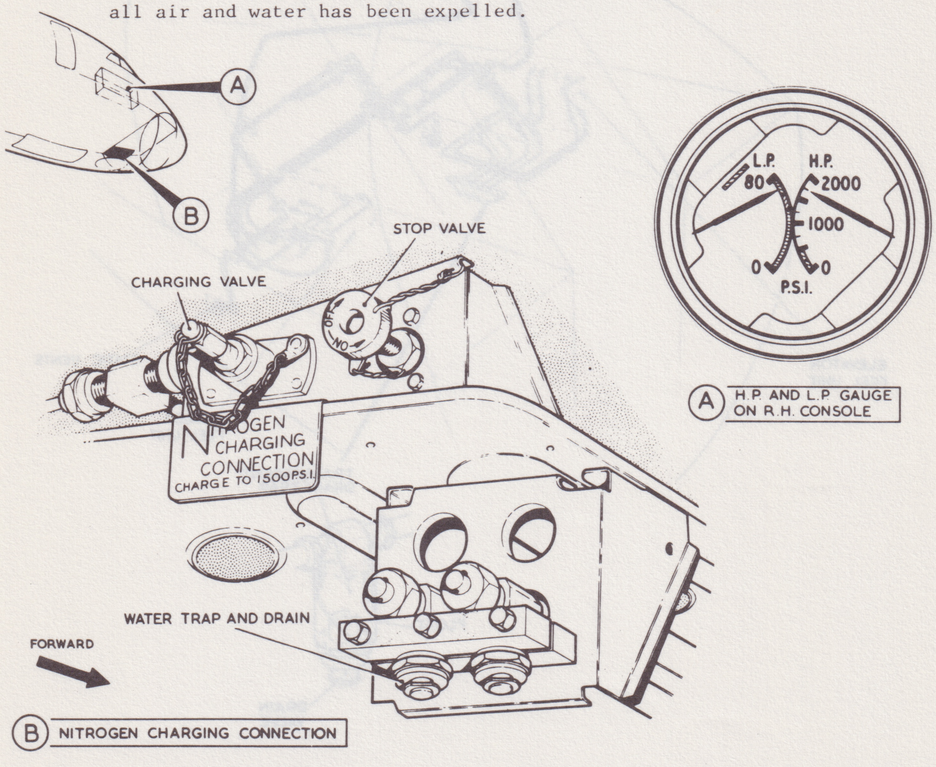
STALL PROTECTION PNEUMATIC SYSTEM

The system is nitrogen-charged, and has one HP bottle and one LP reservoir. The HP bottle is externally charged to 1,500 p.s.i., and maintains the reservoir, via a pressure-reducing valve, at 57 p.s.i.

1. Ensure that the STICK PUSH DUMP VALVE lever, on the centre console, is closed and locked.
2. Ensure that the stop valve, adjacent to the charging valve, is wire-locked in the open position.
3. Connect a filtered nitrogen supply to the charging valve, slowly open the charging trolley shut-off valve and charge the system until a stable reading of 1,500 p.s.i., and 57 p.s.i., is obtained on the respective sectors of the dual HP/LP gauge on the right-hand console.

NOTE: If nitrogen is not available dry air may be used, but the system must be purged and recharged with nitrogen as soon as possible.

Purging is by pressing and holding the water drain valves until all air and water has been expelled.


A
B
STOP VALVE
CHARGING VALVE
OFF
ON
NITROGEN CHARGING CONNECTION
CHARGE TO 1500 P.S.I.
WATER TRAP AND DRAIN
FORWARD
L.P.
H.P.
80
2000
1000
0
0
P.S.I.
A H.P. AND L.P. GAUGE ON R.H. CONSOLE
B NITROGEN CHARGING CONNECTION

Nitrogen Charging
Figure 102

X028358

FUEL

General

Fuel is carried, basically, in three integral tanks, one in each wing and one in the centre section, some aircraft being additionally equipped with an auxiliary tank in the forward freight hold. Vent/surge tanks, in the wing tips, accommodate surge fuel to avoid spillage during ground manoeuvres and admit ram air to pressurize the main tanks when the aircraft is in flight.

Flap-type anti-surge valves, which prevent booster pump starvation, are installed in the webs of wing ribs 1 and 10.

The fuel feed system is arranged so that each engine is normally supplied from its corresponding tank, but a cross-feed system enables either tank to supply both engines. In the event of a single engine failure, both tanks can supply the operative engine.

Centre tank fuel must be transferred to the wing tanks before being fed to the engines.

Fuel is fed to the APU from the left fuel feed system. In addition, a direct feed from the left tank is provided for use in the event of booster pump failure.

Booster pumps are installed within isolation canisters and can be renewed without draining the tanks.

All fuel system joints in the fuselage are fitted with drip shields which drain to atmosphere via a common outlet below the centre keel member.

The tanks can be pressure or gravity refuel/defuelled.

FUEL LOAD

The usable fuel load without auxiliary system is: 3,100 Imperial gallons (3,722 U.S. gal); (14,091 litres).

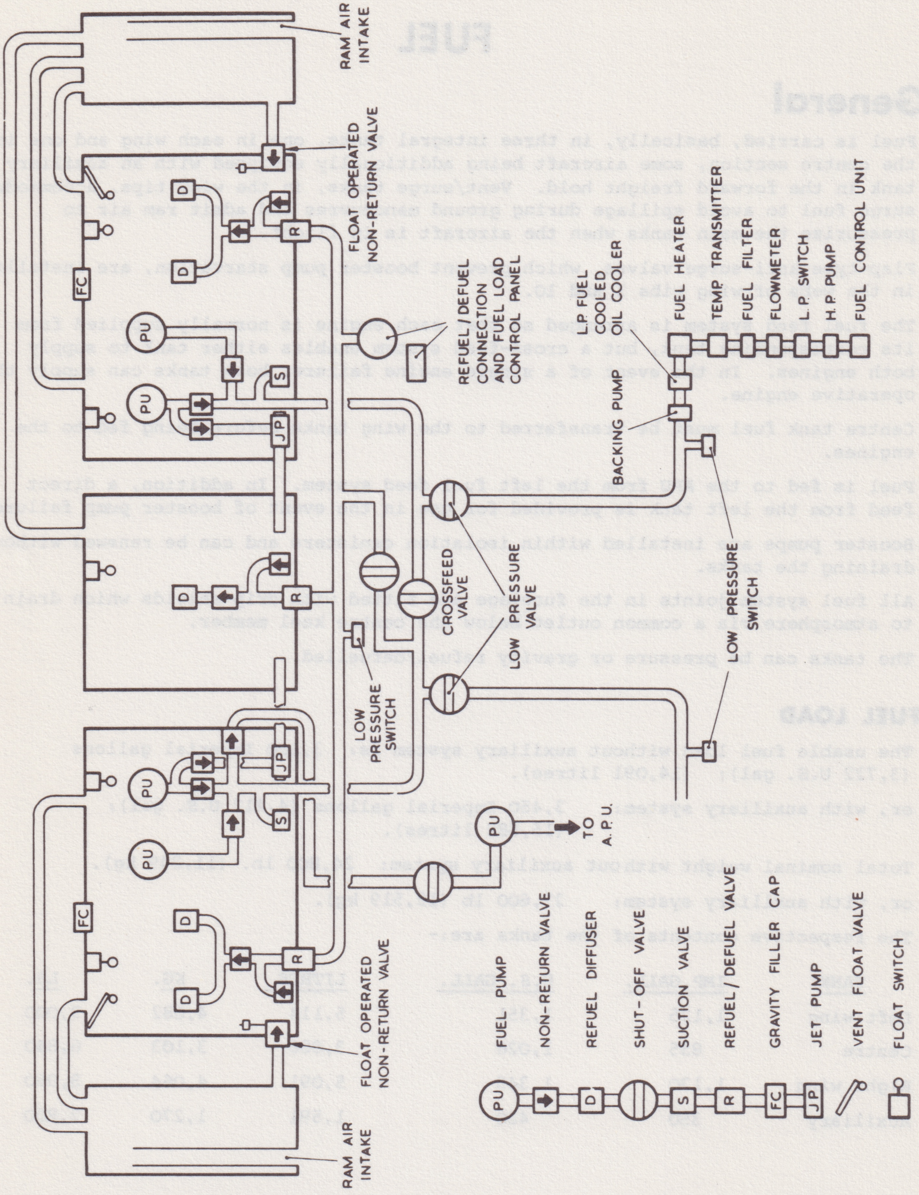
or, with auxiliary system: 3,450 Imperial gallons (4,412 U.S. gal); (15,682 litres).

Total nominal weight without auxiliary system: 24,800 lb. (11,249 kg).

or, with auxiliary system: 27,600 lb (12,519 kg).

The respective contents of the tanks are:-

TANK	IMP.GALL.	U.S. GALL.	LITRES	KG.	LB.
Left wing	1,125	1,351	5,114	4,082	9,000
Centre	855	1,026	3,886	3,103	6,840
Right wing	1,120	1,345	5,091	4,064	8,960
Auxiliary	350	420	1,591	1,270	2,800


RAM AIR INTAKE
FLOAT OPERATED NON-RETURN VALVE
REFUEL / DEFUEL CONNECTION AND FUEL LOAD CONTROL PANEL
LP FUEL COOLED OIL COOLER
FUEL HEATER
TEMP TRANSMITTER
FUEL FILTER
FLOWMETER
L.P. SWITCH
H.P. PUMP
FUEL CONTROL UNIT
BACKING PUMP
CROSSFEED VALVE
LOW PRESSURE VALVE
LOW PRESSURE SWITCH
LOW PRESSURE SWITCH
TO A.P.U.
FC
PU
D
R
S
JP
FLOAT OPERATED NON-RETURN VALVE
RAM AIR INTAKE
PU FUEL PUMP
NON-RETURN VALVE
D REFUEL DIFFUSER
SHUT-OFF VALVE
S SUCTION VALVE
R REFUEL / DEFUEL VALVE
FC GRAVITY FILLER CAP
JP JET PUMP
VENT FLOAT VALVE
FLOAT SWITCH
XAB28/861

Fuel System Diagram
Figure 1

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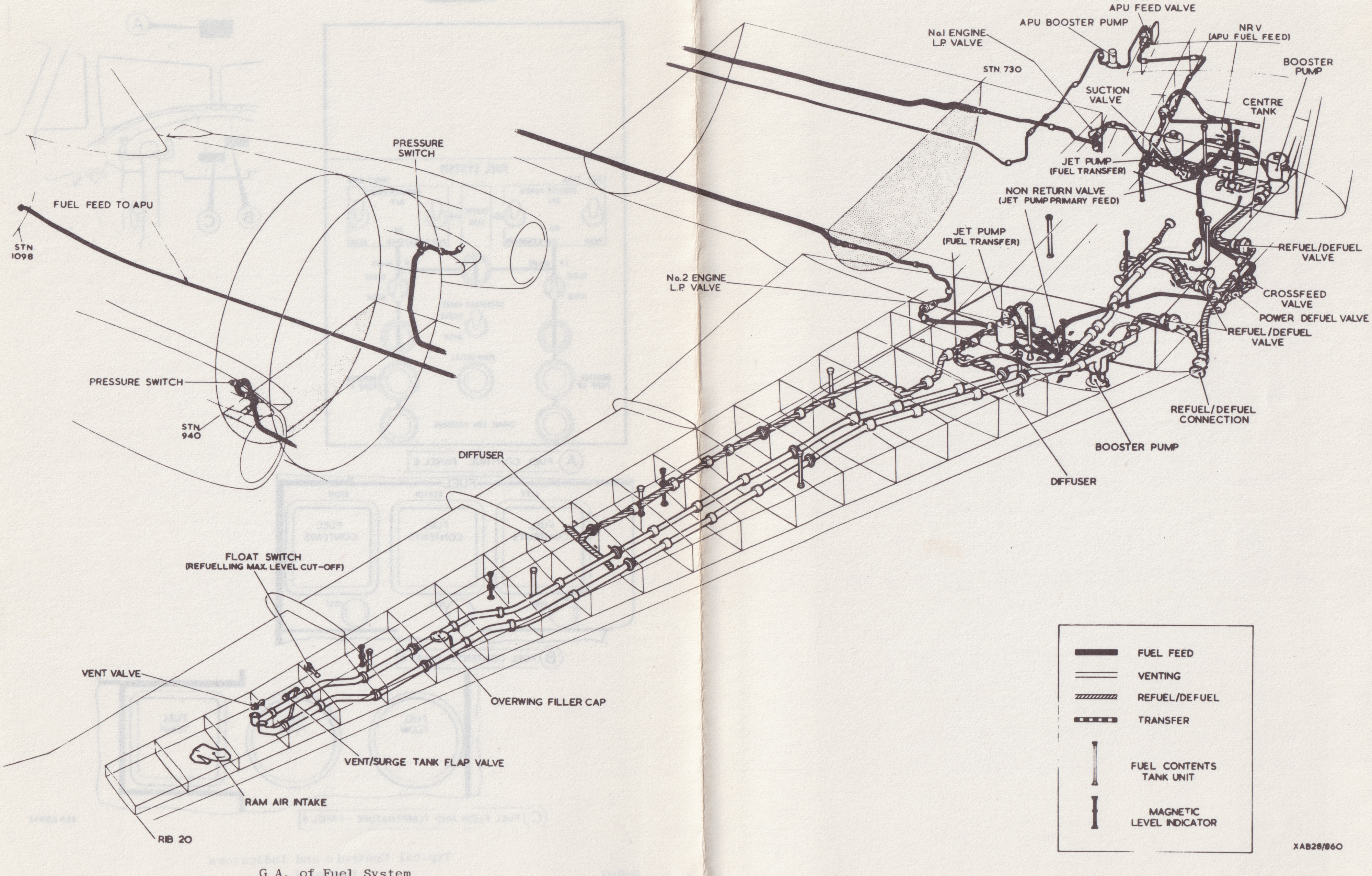
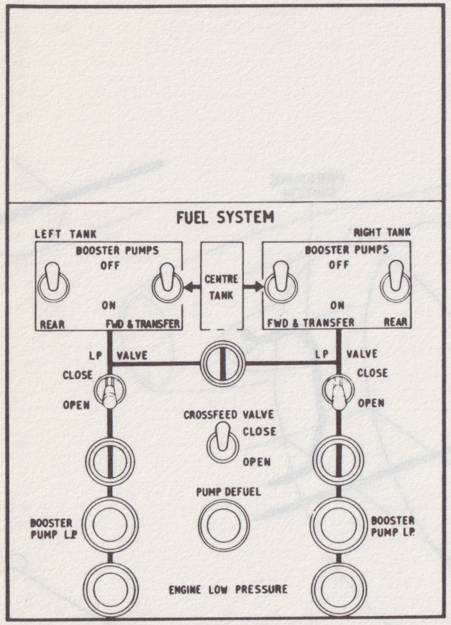
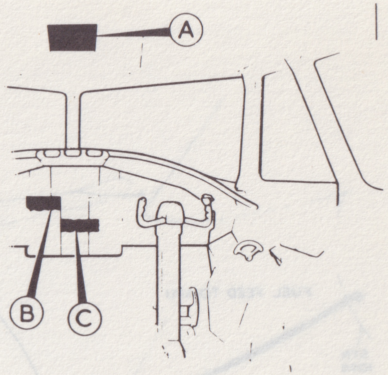
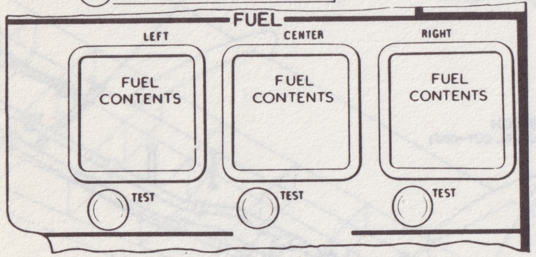

APU FEED VALVE
APU BOOSTER PUMP
No.1 ENGINE L.P. VALVE
NRV (APU FUEL FEED)
BOOSTER PUMP
STN. 730
SUCTION VALVE
CENTRE TANK
JET PUMP (FUEL TRANSFER)
NON RETURN VALVE (JET PUMP PRIMARY FEED)
JET PUMP (FUEL TRANSFER)
REFUEL/DEFUEL VALVE
No.2 ENGINE L.P. VALVE
CROSSFEED VALVE
POWER DEFUEL VALVE
REFUEL/DEFUEL VALVE
REFUEL/DEFUEL CONNECTION
BOOSTER PUMP
DIFFUSER
PRESSURE SWITCH
FUEL FEED TO APU
STN 1098
PRESSURE SWITCH
STN 940
DIFFUSER
FLOAT SWITCH (REFUELLING MAX. LEVEL CUT-OFF)
VENT VALVE
OVERWING FILLER CAP
VENT/SURGE TANK FLAP VALVE
RAM AIR INTAKE
RIB 20
FUEL FEED
VENTING
REFUEL/DEFUEL
TRANSFER
FUEL CONTENTS TANK UNIT
MAGNETIC LEVEL INDICATOR
XAB28/860

G A. of Fuel System
Figure 2

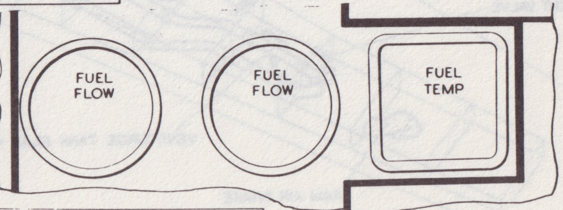

FUEL SYSTEM
LEFT TANK
RIGHT TANK
BOOSTER PUMPS
OFF
ON
REAR
FWD & TRANSFER
CENTRE TANK
BOOSTER PUMPS
OFF
ON
FWD & TRANSFER
REAR
LP VALVE
CLOSE
OPEN
LP VALVE
CLOSE
OPEN
CROSSFEED VALVE
CLOSE
OPEN
PUMP DEFUEL
BOOSTER PUMP LP
BOOSTER PUMP LP
ENGINE LOW PRESSURE



Ⓐ FUEL CONTROL PANEL E


FUEL
LEFT
CENTER
RIGHT
FUEL CONTENTS
FUEL CONTENTS
FUEL CONTENTS
TEST
TEST
TEST

Ⓑ FUEL CONTENTS – PANEL A


FUEL FLOW
FUEL FLOW
FUEL TEMP

Ⓒ FUEL FLOW AND TEMPERATURE – PANEL A

XAB 28/832

Typical Controls and Indicators
Figure 3

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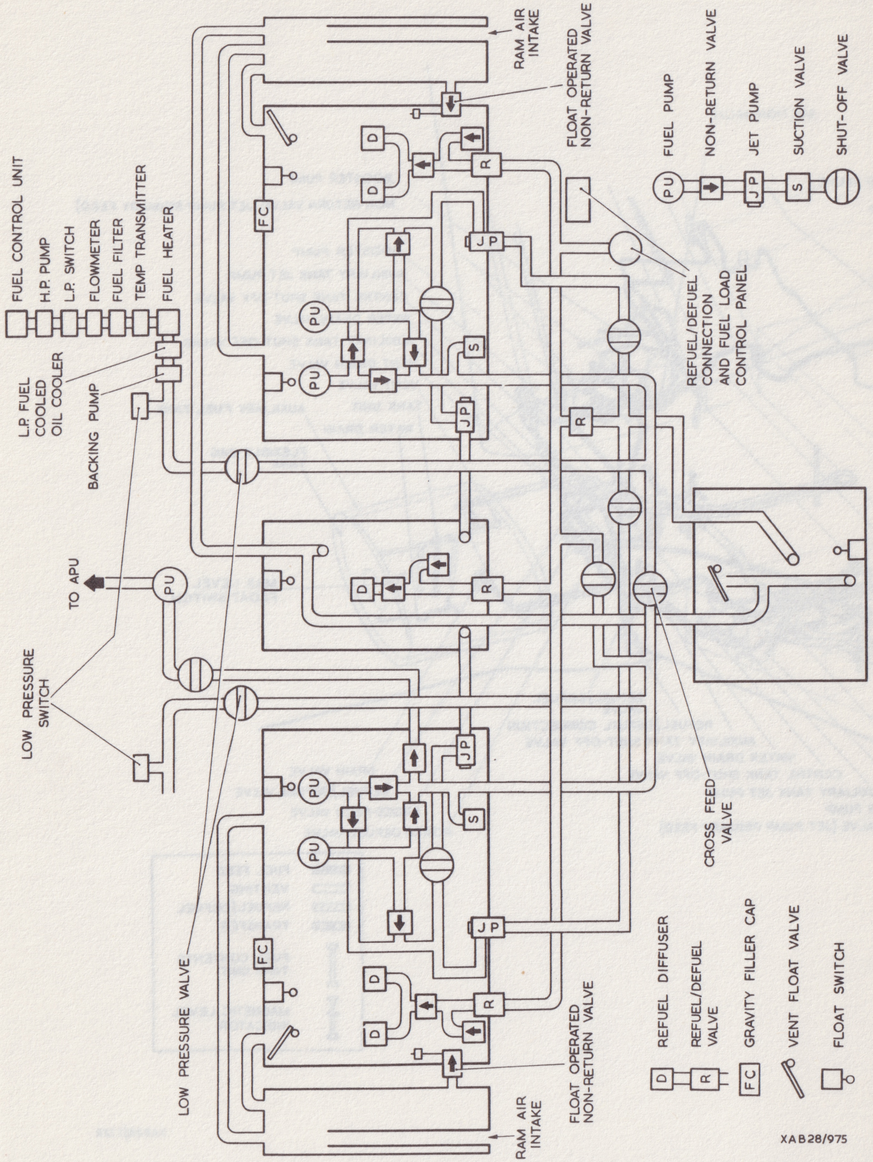
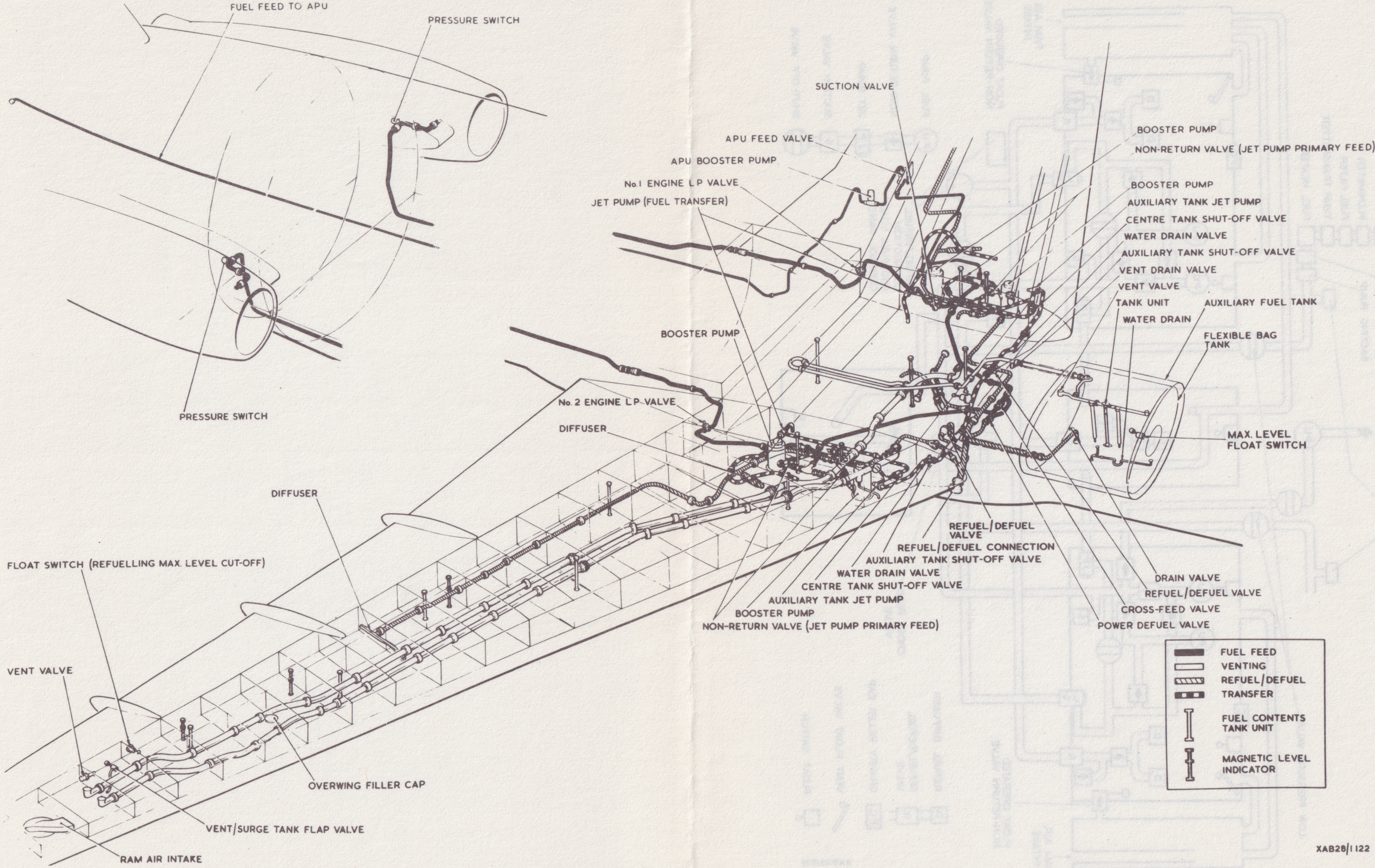
X028359


FUEL CONTROL UNIT
H.P. PUMP
L.P. SWITCH
FLOWMETER
FUEL FILTER
TEMP TRANSMITTER
FUEL HEATER
L.P. FUEL COOLED OIL COOLER
BACKING PUMP
TO APU
PU
LOW PRESSURE SWITCH
LOW PRESSURE VALVE
RAM AIR INTAKE
FLOAT OPERATED NON-RETURN VALVE
FC
D
R
JP
S
REFUEL/DEFUEL CONNECTION AND FUEL LOAD CONTROL PANEL
CROSS FEED VALVE
RAM AIR INTAKE
FLOAT OPERATED NON-RETURN VALVE
PU FUEL PUMP
NON-RETURN VALVE
JP JET PUMP
S SUCTION VALVE
SHUT-OFF VALVE
D REFUEL DIFFUSER
R REFUEL/DEFUEL VALVE
FC GRAVITY FILLER CAP
VENT FLOAT VALVE
FLOAT SWITCH
XAB28/975

Fuel System Diagram
(Aircraft with Auxiliary System)

Figure 4


FUEL FEED TO APU
PRESSURE SWITCH
PRESSURE SWITCH
SUCTION VALVE
APU FEED VALVE
APU BOOSTER PUMP
No.1 ENGINE L.P. VALVE
JET PUMP (FUEL TRANSFER)
BOOSTER PUMP
No. 2 ENGINE L.P. VALVE
DIFFUSER
DIFFUSER
FLOAT SWITCH (REFUELLING MAX. LEVEL CUT-OFF)
VENT VALVE
OVERWING FILLER CAP
VENT/SURGE TANK FLAP VALVE
RAM AIR INTAKE
BOOSTER PUMP
NON-RETURN VALVE (JET PUMP PRIMARY FEED)
BOOSTER PUMP
AUXILIARY TANK JET PUMP
CENTRE TANK SHUT-OFF VALVE
WATER DRAIN VALVE
AUXILIARY TANK SHUT-OFF VALVE
VENT DRAIN VALVE
VENT VALVE
TANK UNIT
AUXILIARY FUEL TANK
WATER DRAIN
FLEXIBLE BAG TANK
MAX. LEVEL FLOAT SWITCH
REFUEL/DEFUEL VALVE
REFUEL/DEFUEL CONNECTION
AUXILIARY TANK SHUT-OFF VALVE
WATER DRAIN VALVE
CENTRE TANK SHUT-OFF VALVE
AUXILIARY TANK JET PUMP
BOOSTER PUMP
NON-RETURN VALVE (JET PUMP PRIMARY FEED)
DRAIN VALVE
REFUEL/DEFUEL VALVE
CROSS-FEED VALVE
POWER DEFUEL VALVE
FUEL FEED
VENTING
REFUEL/DEFUEL
TRANSFER
FUEL CONTENTS TANK UNIT
MAGNETIC LEVEL INDICATOR
XAB28/1122

X028360

G.A. of Fuel System
(Aircraft with Auxiliary System)
Figure 5

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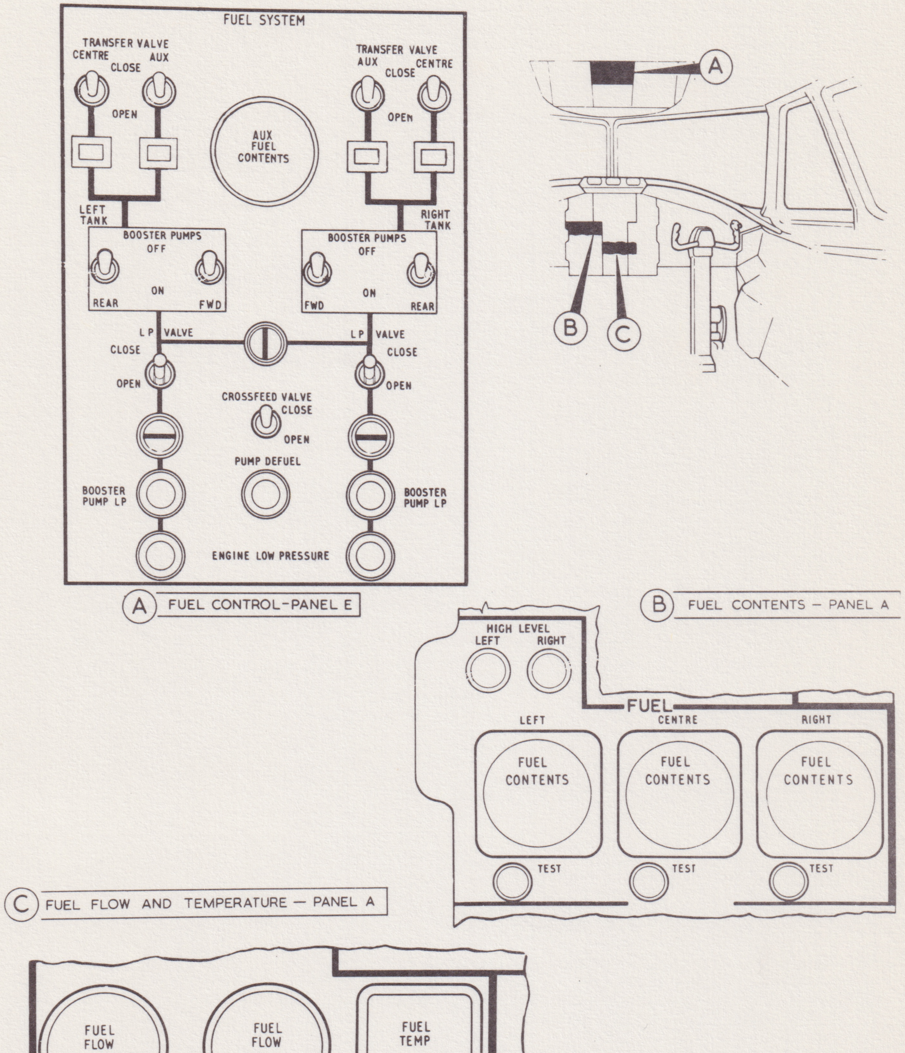

FUEL SYSTEM
TRANSFER VALVE
CENTRE
CLOSE
AUX
OPEN
TRANSFER VALVE
AUX
CLOSE
CENTRE
OPEN
AUX FUEL CONTENTS
LEFT TANK
RIGHT TANK
BOOSTER PUMPS
OFF
ON
REAR
FWD
BOOSTER PUMPS
OFF
ON
FWD
REAR
L P VALVE
CLOSE
OPEN
L P VALVE
CLOSE
OPEN
CROSSFEED VALVE
CLOSE
OPEN
PUMP DEFUEL
BOOSTER PUMP LP
BOOSTER PUMP LP
ENGINE LOW PRESSURE
A
B
C
A FUEL CONTROL-PANEL E
B FUEL CONTENTS – PANEL A
HIGH LEVEL
LEFT
RIGHT
FUEL
LEFT
CENTRE
RIGHT
FUEL CONTENTS
FUEL CONTENTS
FUEL CONTENTS
TEST
TEST
TEST
C FUEL FLOW AND TEMPERATURE – PANEL A
FUEL FLOW
FUEL FLOW
FUEL TEMP

XABOO/7157

Typical Controls and Indicators
(Aircraft with Auxiliary System)
Figure 6

FUEL - SERVICING

General

All normal servicing procedures, with the exception of power defuelling, can be carried out without the need to enter the aircraft.

An external fuel load control panel is linked to the electronic contents gauging system and contains fuel quantity preselectors, together with control switches and indicator lights for automatic refuel/defuelling, also for manual refuelling.

All tanks should be refuel/defuelled simultaneously to maintain nominal ground attitude (i.e. wings level, nose down ½ deg), to facilitate the checking of fuel levels.

PRECAUTIONS

On no account must fuel servicing procedures be commenced until the following conditions have been established, and adequate measures taken to ensure that they are maintained.

1. APU not to be STARTED whilst fueller hose is being connected, or at any time during pressure refuelling. (It can be run, provided it is started beforehand).
2. No fueller vehicle within 30 ft. radius of aircraft tail cone.
3. No potential source of ignition, e.g. ground support equipment etc., within 20 ft. radius of vent/surge tank wing-tip vents.
4. Man stationed at fueller to stop delivery in event of overfuelling.

IF FUEL SPILLAGE OCCURS

1. Stop delivery, and shut down the APU - IMMEDIATELY.
2. Remove all spilt fuel from vicinity of aircraft - DON'T USE SAWDUST - and do not re-start APU until ground is completely clear.

WATER DRAIN CHECKS

The six tank water drain valves should be checked for water immediately before refuelling and again afterward. The post-refuelling check should be delayed as long as possible to allow any water to settle.

If water is found, check ALL fuel system water drains, including the engine low-pressure filter bowls - see Engines (Servicing) Group 4.

REFUELLING

NOTE: Fueller delivery pressure not to exceed 50 p.s.i.

AUTOMATIC

1. Connect the fueller hose to the refuel/defuel connection, not forgetting to connect the hose earth cable to the adjacent point.
2. At the fuel load control panel, check the attitude monitor reading and consult the correction charts to determine the required fuel quantity.
3. Set the MASTER SWITCH to on; the POWER ON light must come on.
4. Set the AUTO/MANUAL switches to AUTO, and the REFUEL/DEFUEL switches to REFUEL.
5. Set each tank preselector to the requisite load; their respective tank selected lights must come on.
6. Operate the fueller; when the correct load is reached, the tank selected lights will go out.
7. Check the fuel contents on the underwing magnetic fluid level indicators (M.F.L.Is) together with the attitude correction charts, and adjust the load if necessary.

   NOTE: To operate the M.F.L.Is, press up with screwdriver, turn through 90 deg and release to allow the spring-loaded tube to eject. Pull tube down to fullest extent, then push upward using light pressure; when magnets coincide, a distinct resistance will be felt. The reading can now be taken.

8. Stop the fueller, set all switches to OFF, and disconnect the fueller from aircraft.

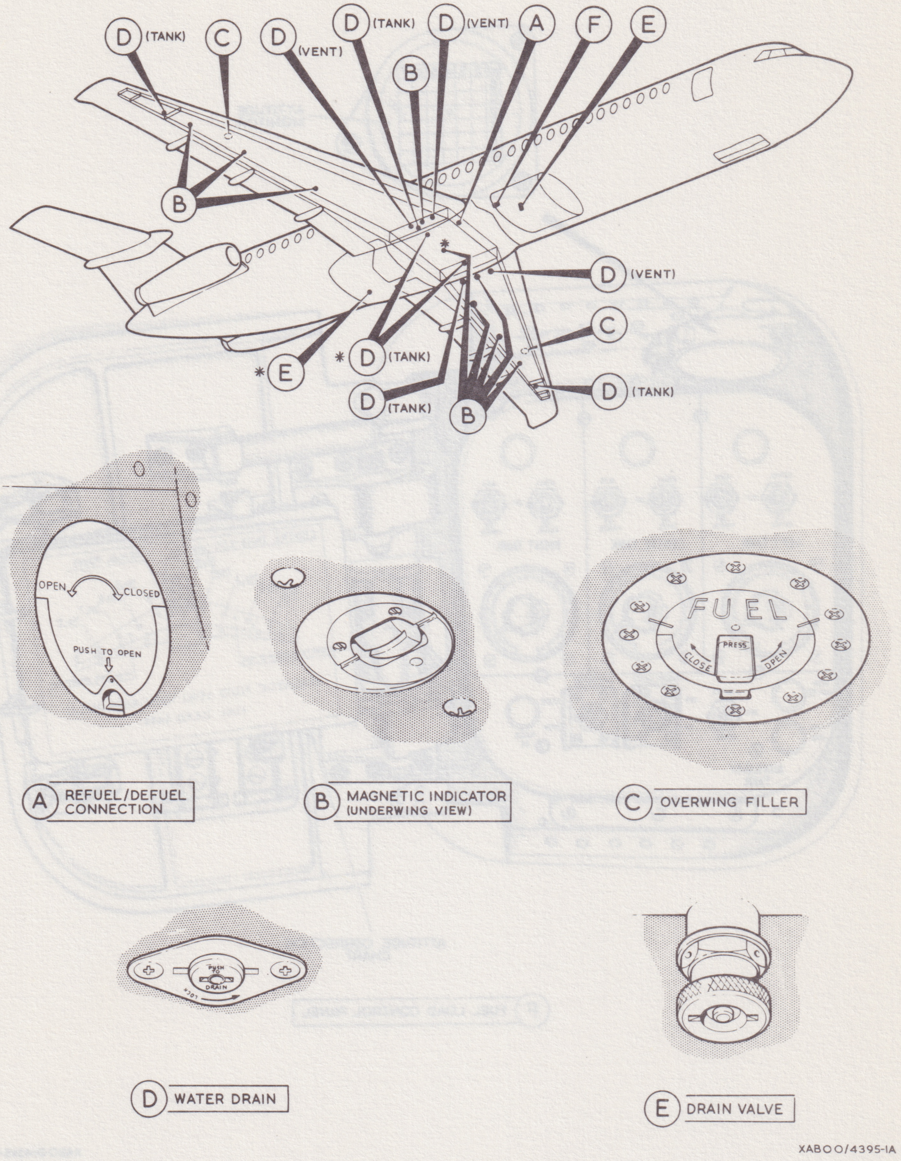
MANUAL

Refuelling by manual control is the same as automatic, except that the AUTO/MANUAL switches are set to MANUAL, and fuel delivery monitored by the operator who must shut it off, by moving the REFUEL/DEFUEL switch to OFF, when the desired load is reached.

OVERWING (GRAVITY)

Gravity refuelling can be carried out via the two overwing filling points. Fuel must be transferred to the centre tank, using the rear booster pump in each wing tank. Select power defuel on the fuel load control panel, and set the centre tank refuel/defuel valve to refuel.

X028364


D (TANK)
C
D (VENT)
D (TANK)
B
D (VENT)
A
F
E
B
D (VENT)
C
D (TANK)
*D (TANK)
*E
D (TANK)
B
OPEN
CLOSED
PUSH TO OPEN
FUEL
PRESS
CLOSE
OPEN
PUSH TO DRAIN
LOCK
XAB00/4395-1A

A REFUEL/DEFUEL CONNECTION

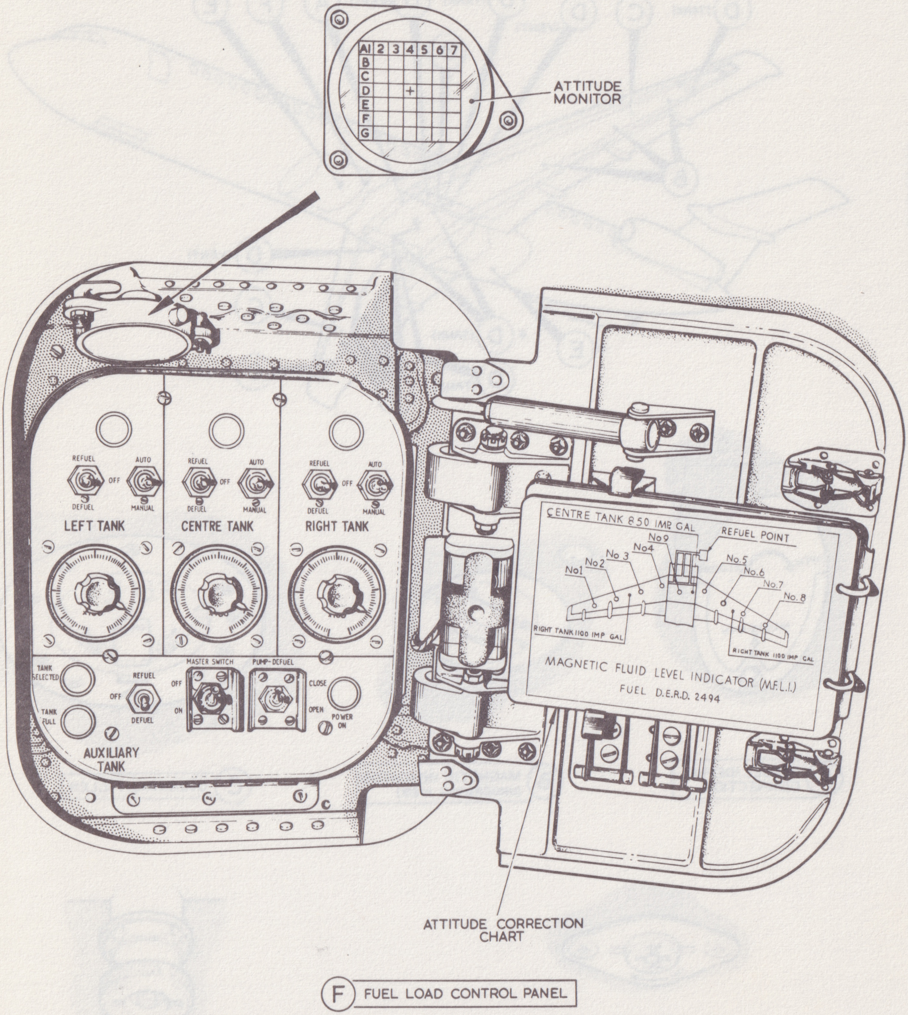
B MAGNETIC INDICATOR (UNDERWING VIEW)

C OVERWING FILLER

D WATER DRAIN

E DRAIN VALVE

Servicing Points (1) - (See also Fig.102)
Figure 101


A1 2 3 4 5 6 7
B
C
D
E
F
G
ATTITUDE MONITOR
REFUEL
OFF
DEFUEL
AUTO
MANUAL
LEFT TANK
CENTRE TANK
RIGHT TANK
TANK SELECTED
TANK FULL
REFUEL
OFF
DEFUEL
MASTER SWITCH
OFF
ON
PUMP-DEFUEL
CLOSE
OPEN
POWER ON
AUXILIARY TANK
CENTRE TANK 850 IMP. GAL
REFUEL POINT
No1
No2
No 3
No4
No9
No.5
No.6
No.7
No. 8
RIGHT TANK 1100 IMP GAL
RIGHT TANK 1100 IMP GAL
MAGNETIC FLUID LEVEL INDICATOR (M.F.L.I.)
FUEL D.E.R.D. 2494
ATTITUDE CORRECTION CHART
F FUEL LOAD CONTROL PANEL

XABOO/4395-2B

Servicing Points (2) - (See also Figure 101)
Figure 102

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X028366

DEFUELLING

NOTE: Fueller suction not to exceed 11 p.s.i.

AUTOMATIC

Procedure for this is the same as for automatic refuelling, except that the REFUEL/DEFUEL switches are set to DEFUEL and suction is used.

MANUAL

Procedure for this is the same as for manual refuelling, except that:-

(a) The AUTO/MANUAL switch set to MANUAL.
(b) The REFUEL/DEFUEL switch set to DEFUEL.
(c) Suction is used.

*POWER

This facility is intended for use when the defuelling rate, by automatic or manual means, is below normal. It utilizes the booster pumps together with a power defuel valve.

Both booster pumps in each wing tank defuel the wings, but only the front booster pumps defuel the centre tank.

Connect ground defuelling equipment and set the PUMP DEFUEL switch, on the fuel load control panel, to OPEN.

If defuelling the right wing tank, set the CROSS FEED VALVE switch, on the flight deck FUEL SYSTEM control panel, to OPEN.
Set the appropriate BOOSTER PUMP switches to ON.

* Model 509 aircraft are not fitted with this facility.

GENERAL CHECKS

Adequate periodic checks should be made to ensure that the fuel system generally is contamination-free.

It is particularly important that the tank interiors of aircraft operating in high ambient temperatures should be inspected regularly, for microbiological (fungal) growth. The spores of the fungus exist in many fuel supplies throughout the world but develop to visible and dangerous form only when in contact with water and fuel at high temperature for extended periods. If allowed to develop, the fungus will cause deterioration of the tank sealant with resultant corrosion of the structure.

APPROVED FUELS

TYPE OF FUEL	BRITISH	CANADIAN	U.S.A.	I.A.T.A.
Kerosine Type (AVTUR: J.P. 1)	D.Eng.R.D.2453 Issue 3 Am 1		A.S.T.M. D.1655-74 JET A.	Kerosine Type Fuel (Nov.1974)
	D.Eng.R.D.2494 Issue 7 Am 1	3-GP-23h	A.S.T.M. D.1655-74 JET A-1	
Wide Cut Fuels (AVTAG: J.P.4)	D.Eng.R.D.2454 Issue 3 Am 1	3-GP-22h	A.S.T.M. D.1655-72 JET B.	J.P.4 Type (Nov.1974)
			MIL-T-5624J J.P.4 Grade	
	D.Eng.R.D.2486 Issue 8 Am 1		MIL-T-5624H J.P.4 Grade	
High Flash Point (AVCAT: J.P.5)	D.Eng.R.D.2498 Issue 6	3-GP-24g	MIL-T-5624J J.P.5 Grade	

TYPE OF FUEL	ROMANIAN STATE	U.S.S.R.	FRENCH	GERMAN
Kerosine Type (AVTUR: J.P. 1)	3754/73 (CS-3)	T.S-1 (Gost 10227 -62 Am 1)	AIR 3405/C	
		T-7 (Gost 12308 -66)		
Wide Cut Fuels (AVTAG: J.P.4)			AIR 3407/B	TL 9130-006 Issue 4
High Flash Point (AVCAT: J.P.5)			AIR 3404/B	TL 9130-007 Issue 4

NOTE: Fuel Specifications D.Eng.R.D.2453 and D.Eng.R.D.2454 already include Hitec E515 (formerly Santolene C) and anti-icing additive to Specification D.Eng.R.D.2451 (Issue 2 or later) to approved limitations.

X028367

HYDRAULIC

General

This section describes only the generation and control of hydraulic power. Information on user systems, for example flying controls, is given in the appropriate section.

Hydraulic power is provided by two basically similar but independent systems; services vital to aircraft safety are supplied by both. In the event of engine pumps being inoperable or for ground servicing purposes, an auxiliary source of power from a.c. electrically driven pumps is available. The a.c. pumps maintain full system pressure.

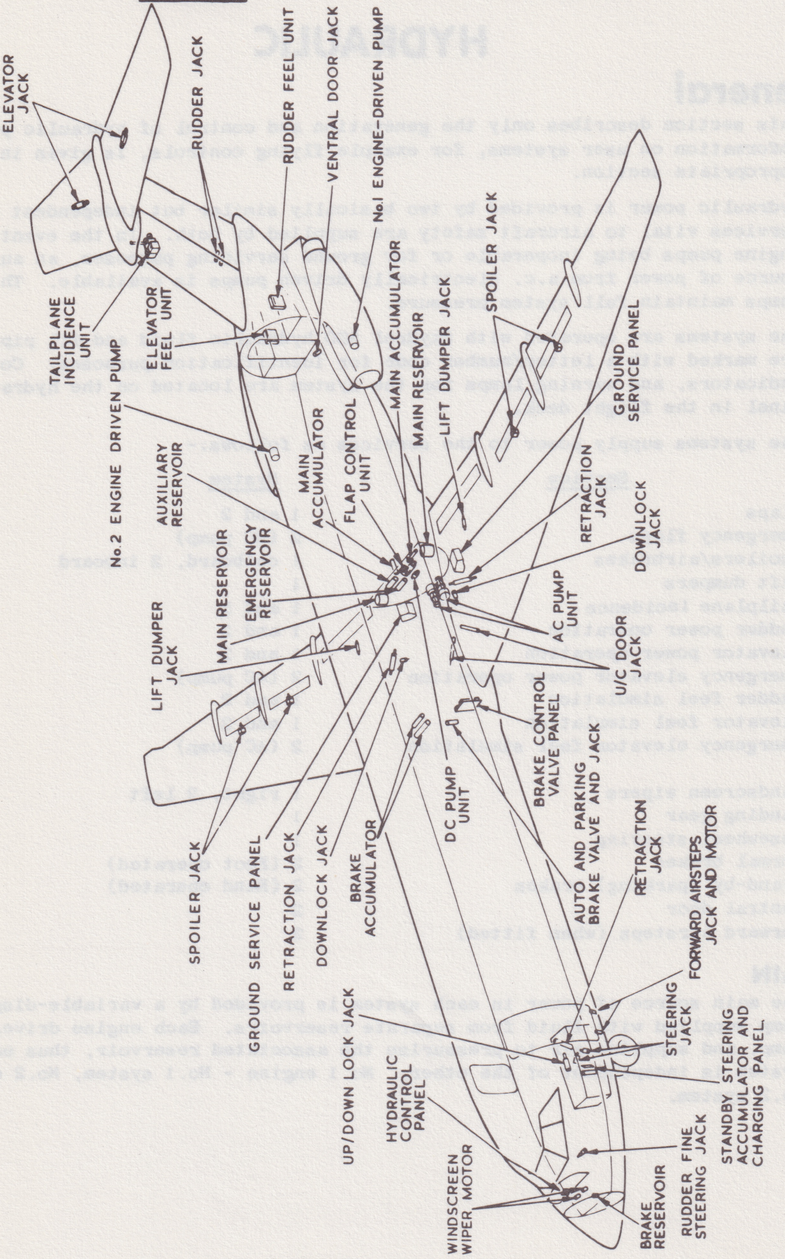
The systems are operated with Skydrol 500 hydraulic fluid and all pipelines are marked with a letter/number code for identification purposes. Controls, indicators, and warning lamps for the system are located on the hydraulic panel in the flight deck.

The systems supply power to the services as follows:-

Service	System
Flaps	1 and 2
Emergency flaps	2 (DC pump)
Spoilers/airbrakes	1 outboard, 2 inboard
Lift dumpers	1
Tailplane incidence	1 and 2
Rudder power operation	1 and 2
Elevator power operation	1 and 2
Emergency elevator power operation	2 (AC pump)
Rudder feel simulation	1 and 2
Elevator feel simulation	1 and 2
Emergency elevator feel simulation	2 (AC pump)
Windscreen wipers	1 right, 2 left
Landing gear	1
Nosewheel steering	1
Normal brakes	2 (Foot operated)
Stand-by (parking) brakes	2 (Hand operated)
Ventral door	2
Forward airsteps (when fitted)	2

MAIN

The main source of power in each system is provided by a variable-displacement pump supplied with fluid from separate reservoirs. Each engine drives a pump, and supplies air to pressurize the associated reservoir, thus each system is independent of the other; No.1 engine - No.1 system, No.2 engine - No.2 system.


ELEVATOR JACK
RUDDER JACK
RUDDER FEEL UNIT
VENTRAL DOOR JACK
No.1 ENGINE-DRIVEN PUMP
TAILPLANE INCIDENCE UNIT
ELEVATOR FEEL UNIT
No.2 ENGINE DRIVEN PUMP
SPOILER JACK
MAIN ACCUMULATOR
LIFT DUMPER JACK
MAIN RESERVOIR
GROUND SERVICE PANEL
AUXILIARY RESERVOIR
MAIN ACCUMULATOR
FLAP CONTROL UNIT
RETRACTION JACK
DOWNLOCK JACK
MAIN RESERVOIR
EMERGENCY RESERVOIR
LIFT DUMPER JACK
AC PUMP UNIT
U/C DOOR JACK
BRAKE CONTROL VALVE PANEL
AUTO AND PARKING BRAKE VALVE AND JACK
DC PUMP UNIT
RETRACTION JACK
FORWARD AIRSTEPS JACK AND MOTOR
SPOILER JACK
GROUND SERVICE PANEL
RETRACTION JACK
DOWNLOCK JACK
BRAKE ACCUMULATOR
STEERING JACK
STANDBY STEERING ACCUMULATOR AND CHARGING PANEL
UP/DOWN LOCK JACK
HYDRAULIC CONTROL PANEL
WINDSCREEN WIPER MOTOR
BRAKE RESERVOIR
RUDDER FINE STEERING JACK
AB29/583A

Hydraulic Components

Figure 1

X024603

Air bled from the engines is passed, via a pressure reducing valve, non-return valve and filter to the reservoir. The non-return valve retains pressure in the reservoir when the engines are stopped. Fluid level is shown at a sight-glass on each main reservoir, and also by a dual indicator on the flight deck hydraulic control panel.

The engine-driven pumps (EDP) maintain the system pressures at approximately 3,000 p.s.i. Delivery is regulated by the pump pressure control acting in response to system pressure. With engines running and the accumulators fully charged hydraulically, the pumps remain slightly 'on stroke' to compensate for normal system leakage.

Shut-off valves fitted in the EDP suction lines operate in conjunction with the flight deck fire handles, to cut off the pump fluid supply in event of engine fire.

Pressure fluid from the pumps passes through adjacent high-pressure filters, and is piped forward to connections through the roof of the main undercarriage bay, in which the majority of the hydraulic components are located. From the roof connections the fluid passes, via pressure switches and non-return valves, to four-way pieces for direct distribution to the accumulators and sub-system control valves, and via servo power valves to the flight control services. The non-return valves isolate the pressure switches and engine-driven pumps when the systems are pressurized by auxiliary power or ground rigs.

Upon selection of a service, the main accumulator initiates operation, the pump pressure control senses the system pressure-drop and increases pump delivery to maintain pressure during service operation. When the operation is complete, and the accumulator hydraulically recharged, the pump reverts to the 'on stroke' condition.

Delivery ceases when the pump is 'off-loaded', but pressure within the pump is maintained at approximately 300 p.s.i., for cooling and lubrication purposes.

A ground service panel is provided for each system. The panels, adjacent to the wing-root trailing edges, have self-sealing couplings for connecting ground test rigs, charging valves and gauges for the main accumulator and reservoir air pressures, and a system fluid drain cock.

AUXILIARY

Each hydraulic system incorporates an independent source of auxiliary power, comprising a variable displacement pump driven by an a.c. electric motor, and supplied with fluid from the associated reservoir. The a.c. pumps will function with the reservoirs unpressurized, and are air-cooled by integral blower fans.

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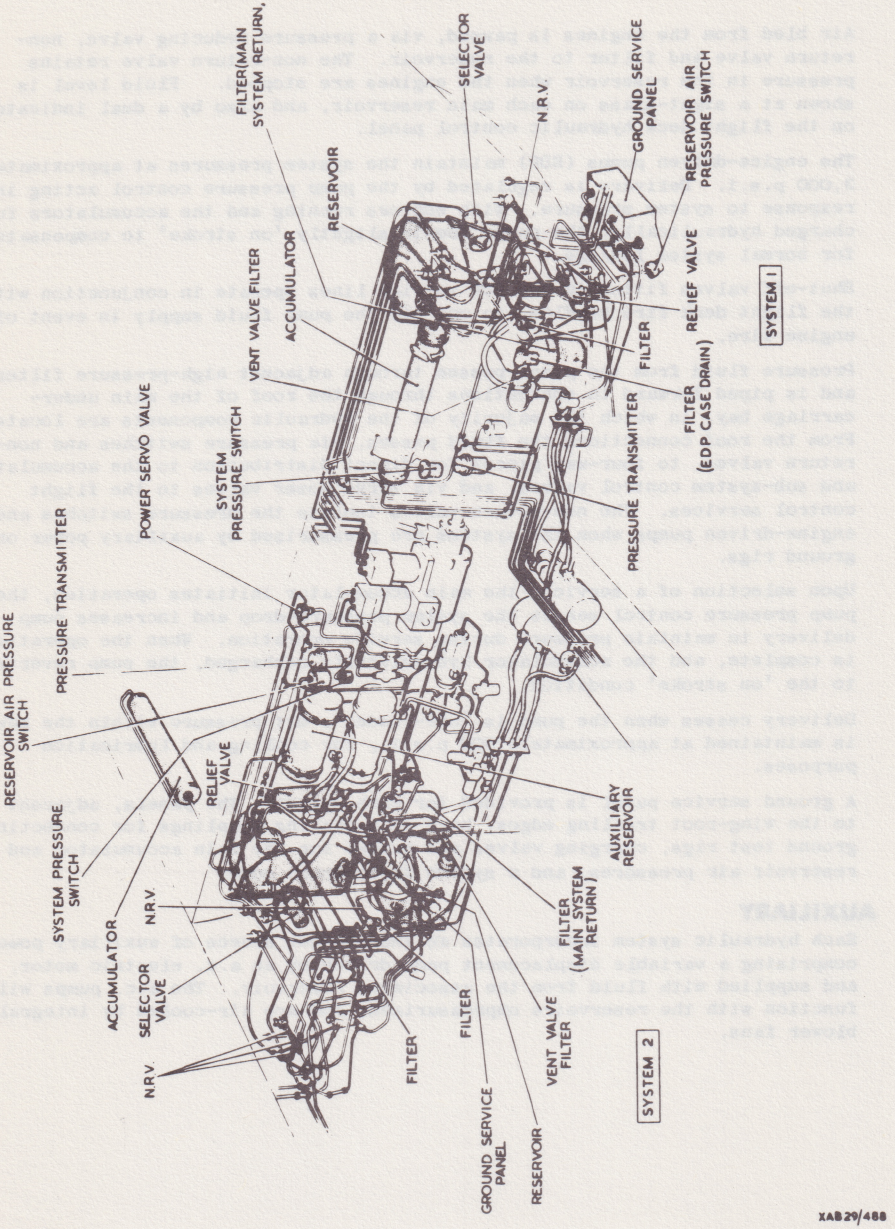

FILTER(MAIN SYSTEM RETURN,
SELECTOR VALVE
N.R.V.
GROUND SERVICE PANEL
RESERVOIR AIR PRESSURE SWITCH
RESERVOIR
ACCUMULATOR
VENT VALVE FILTER
RELIEF VALVE
SYSTEM I
FILTER
FILTER (EDP CASE DRAIN)
POWER SERVO VALVE
SYSTEM PRESSURE SWITCH
PRESSURE TRANSMITTER
PRESSURE TRANSMITTER
RESERVOIR AIR PRESSURE SWITCH
RELIEF VALVE
AUXILIARY RESERVOIR
SYSTEM PRESSURE SWITCH
ACCUMULATOR
N.R.V.
FILTER (MAIN SYSTEM RETURN)
SELECTOR VALVE
N.R.V.
FILTER
FILTER
VENT VALVE FILTER
SYSTEM 2
GROUND SERVICE PANEL
RESERVOIR
XAB29/488

Main Systems in Main Undercarriage Bay
Figure 2

B068176

Each a.c. pump is controlled by a switch on the hydraulic control panel; No.2 a.c. pump is also operated by the emergency elevator switch, independently of and overriding the normal a.c. pump switch.

When No.1 auxiliary a.c. pump is selected, the pump is supplied with fluid direct from the main reservoir and delivers pressure fluid to the associated main system pressure line via a pressure switch, non-return valve and high-pressure filter.

Upon normal selection of No.2 auxiliary a.c. pump a shut-off valve, in the main reservoir to pump suction line opens, allowing fluid to flow to the pump. The pump delivers pressure fluid to a selector valve, via a non-return valve and high-pressure filter. The selector valve directs the pressure fluid, via another pressure switch and non-return valve, to the associated main system pressure line.

When emergency elevator is selected a shut-off valve, in the emergency reservoir to pump line, opens permitting fluid to flow to the pump. The selector valve directs the pressure fluid via a pressure switch to an emergency feel jack and to the No.2 system elevator power control units.

The non-return valves fitted in the pressure supply lines isolate the pressure switch and a.c. pump when the hydraulic system is pressurized from the EDP or ground test rig.

When the a.c. pump is operating and the associated accumulators are fully charged hydraulically, the pump assumes a minimum flow condition to compensate for normal system leakage.

Utilisation of the a.c. pumps for ground servicing is permitted provided that, if the ambient air temperature is high, the inner main undercarriage doors are lowered to increase cooling airflow.

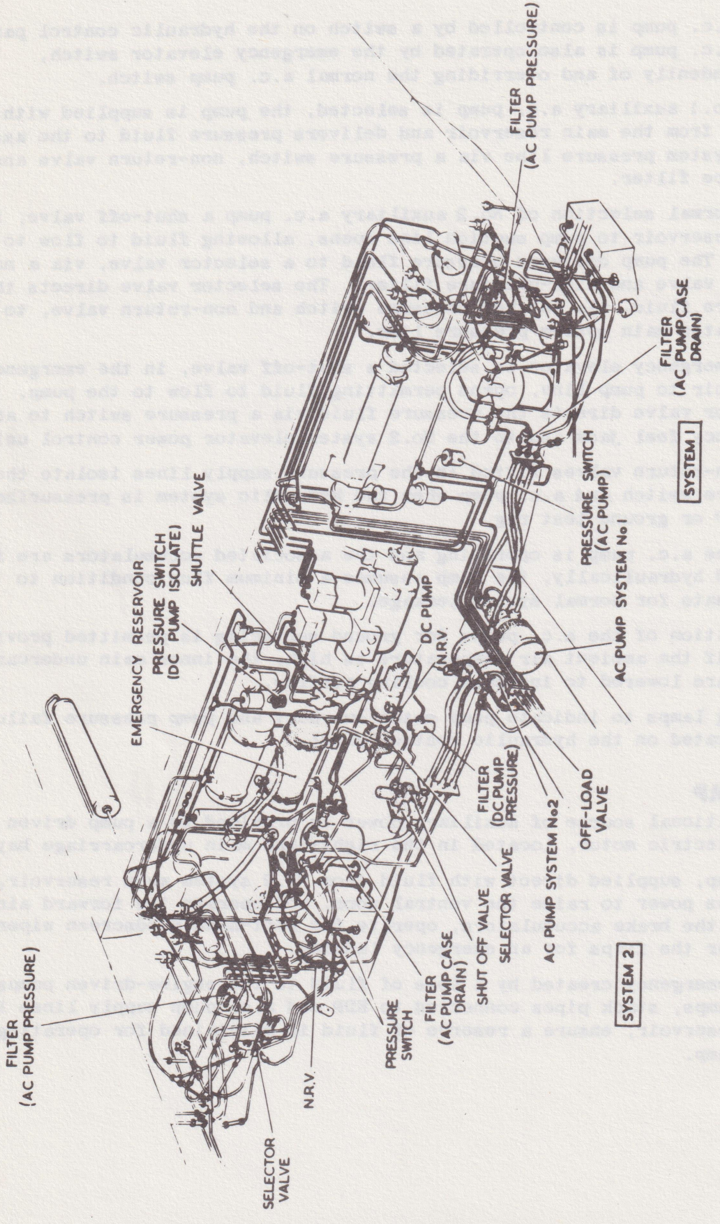
Warning lamps to indicate pump motor overheat and pump pressure failure are located on the hydraulic control panel.

DC PUMP

An additional source of auxiliary power is provided by a pump driven by a d.c. electric motor, located in the right-hand main undercarriage bay.

The pump, supplied direct with fluid from No.2 system main reservoir, provides power to raise the ventral door, and operate the forward airsteps, charge the brake accumulators, operate the left-hand windscreen wiper, and to lower the flaps for an emergency landing.

In an emergency created by a loss of fluid to the engine-driven pumps and a.c. pumps, stack pipes connected to EDP and a.c. pump supply lines in No.2 main reservoir, ensure a reserve of fluid is maintained for operating the d.c. pump.


FILTER (AC PUMP PRESSURE)
SELECTOR VALVE
N.R.V.
EMERGENCY RESERVOIR
PRESSURE SWITCH (DC PUMP ISOLATE)
SHUTTLE VALVE
DC PUMP
N.R.V.
PRESSURE SWITCH
FILTER (AC PUMP CASE DRAIN)
SHUT OFF VALVE
SELECTOR VALVE
FILTER (DC PUMP PRESSURE)
AC PUMP SYSTEM No2
OFF-LOAD VALVE
SYSTEM 2
AC PUMP SYSTEM No1
PRESSURE SWITCH (AC PUMP)
SYSTEM 1
FILTER (AC PUMP CASE DRAIN)
FILTER (AC PUMP PRESSURE)
XAB29/489B

Auxiliary Systems in Main Undercarriage Bay

Figure 3

B082199

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The d.c. pump is controlled by a three-way switch on the hydraulic control panel, by micro-switches in the ventral door and forward airsteps operating mechanisms, or by toggle switches at the internal and external control handles; both switches are wired into the d.c. pump control circuit.

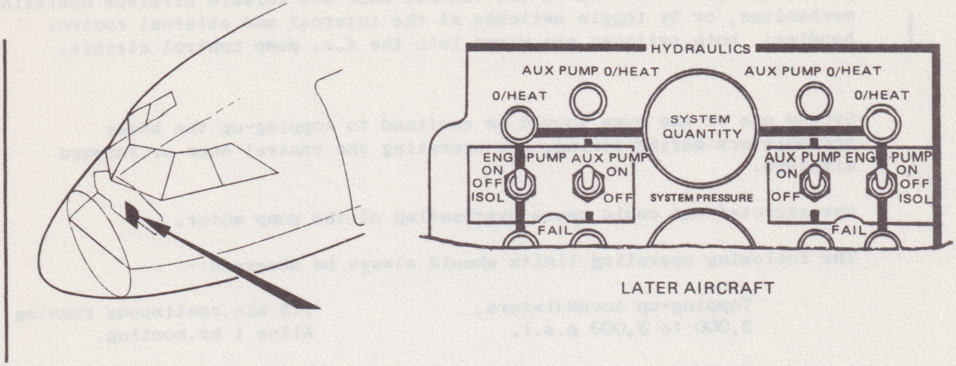
Ground use of the pump should be confined to topping-up the brake accumulators during towing, and operating the ventral door or forward airsteps.

Unrestricted use could cause overheating of the pump motor.

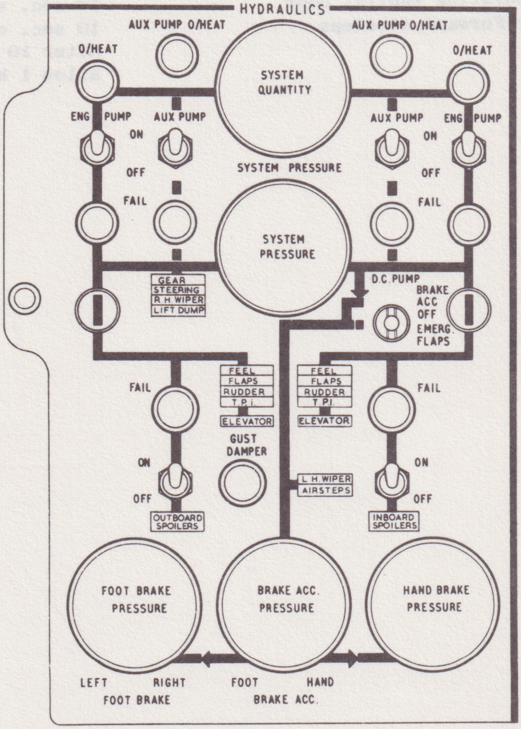
The following operating limits should always be observed:-

Topping-up Accumulators, 2,000 to 3,000 p.s.i.	1.5 min.continuous running Allow 1 hr.cooling.
Operating Ventral Door or Forward Airsteps	10 sec. at full load. 10 sec. cooling. After 10 consecutive operations, allow 1 hr. cooling.

BC8220C


HYDRAULICS
AUX PUMP O/HEAT
AUX PUMP O/HEAT
O/HEAT
O/HEAT
SYSTEM QUANTITY
ENG PUMP
ON
OFF
ISOL
AUX PUMP
ON
OFF
AUX PUMP
ON
OFF
ENG PUMP
ON
OFF
ISOL
SYSTEM PRESSURE
FAIL
FAIL

LATER AIRCRAFT


HYDRAULICS
AUX PUMP O/HEAT
AUX PUMP O/HEAT
O/HEAT
O/HEAT
SYSTEM QUANTITY
ENG PUMP
AUX PUMP
AUX PUMP
ENG PUMP
ON
OFF
ON
OFF
SYSTEM PRESSURE
FAIL
FAIL
SYSTEM PRESSURE
GEAR
STEERING
R.H. WIPER
LIFT DUMP
D.C. PUMP
BRAKE
ACC
OFF
EMERG.
FLAPS
FEEL
FLAPS
RUDDER
T.P.I.
ELEVATOR
FEEL
FLAPS
RUDDER
T.P.I.
ELEVATOR
FAIL
FAIL
GUST
DAMPER
ON
OFF
OUTBOARD
SPOILERS
L.H. WIPER
AIRSTEPS
ON
OFF
INBOARD
SPOILERS
FOOT BRAKE
PRESSURE
BRAKE ACC.
PRESSURE
HAND BRAKE
PRESSURE
LEFT
RIGHT
FOOT BRAKE
FOOT
HAND
BRAKE ACC.

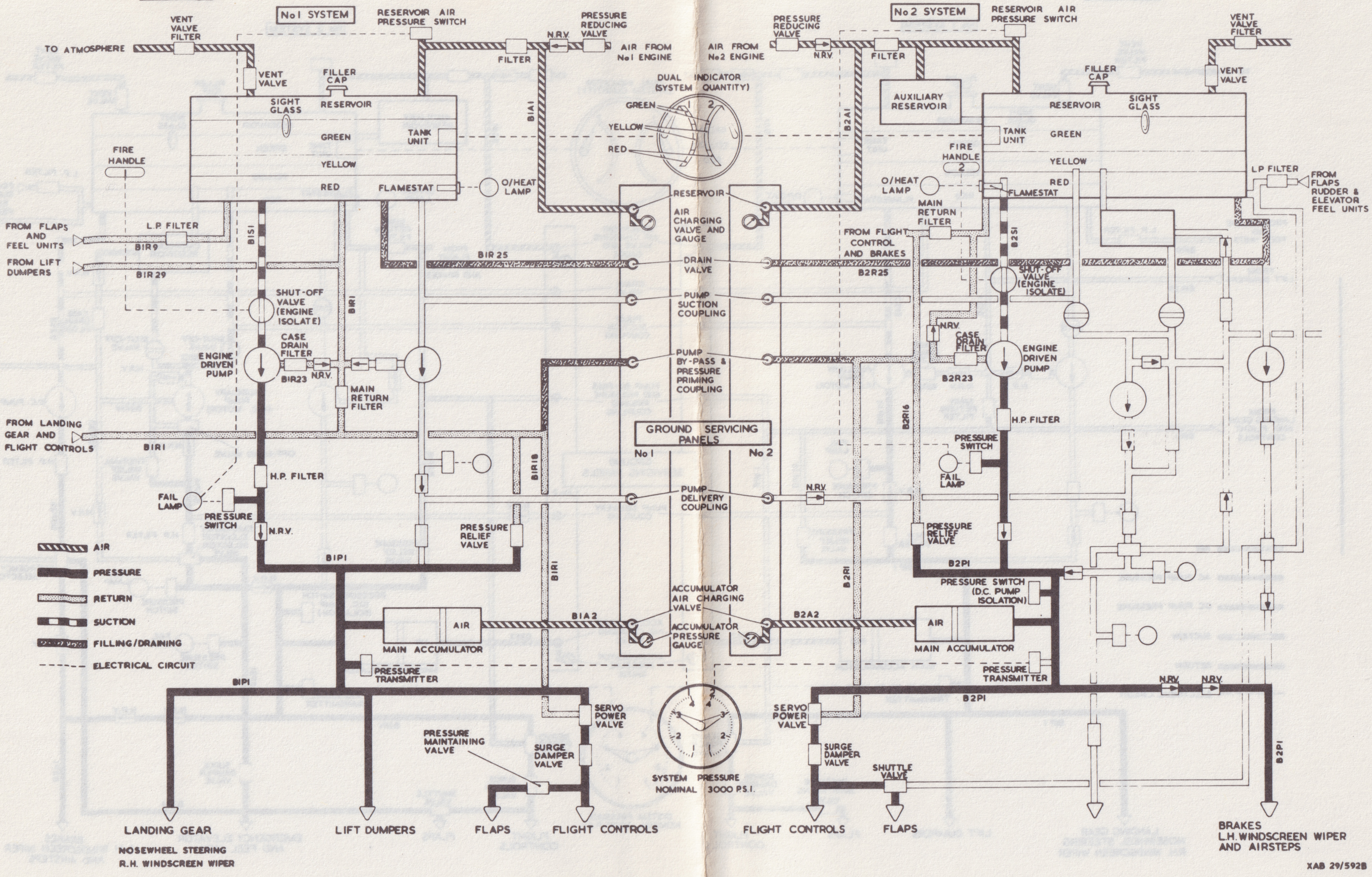
XABOO/7158

Controls in Flight Deck

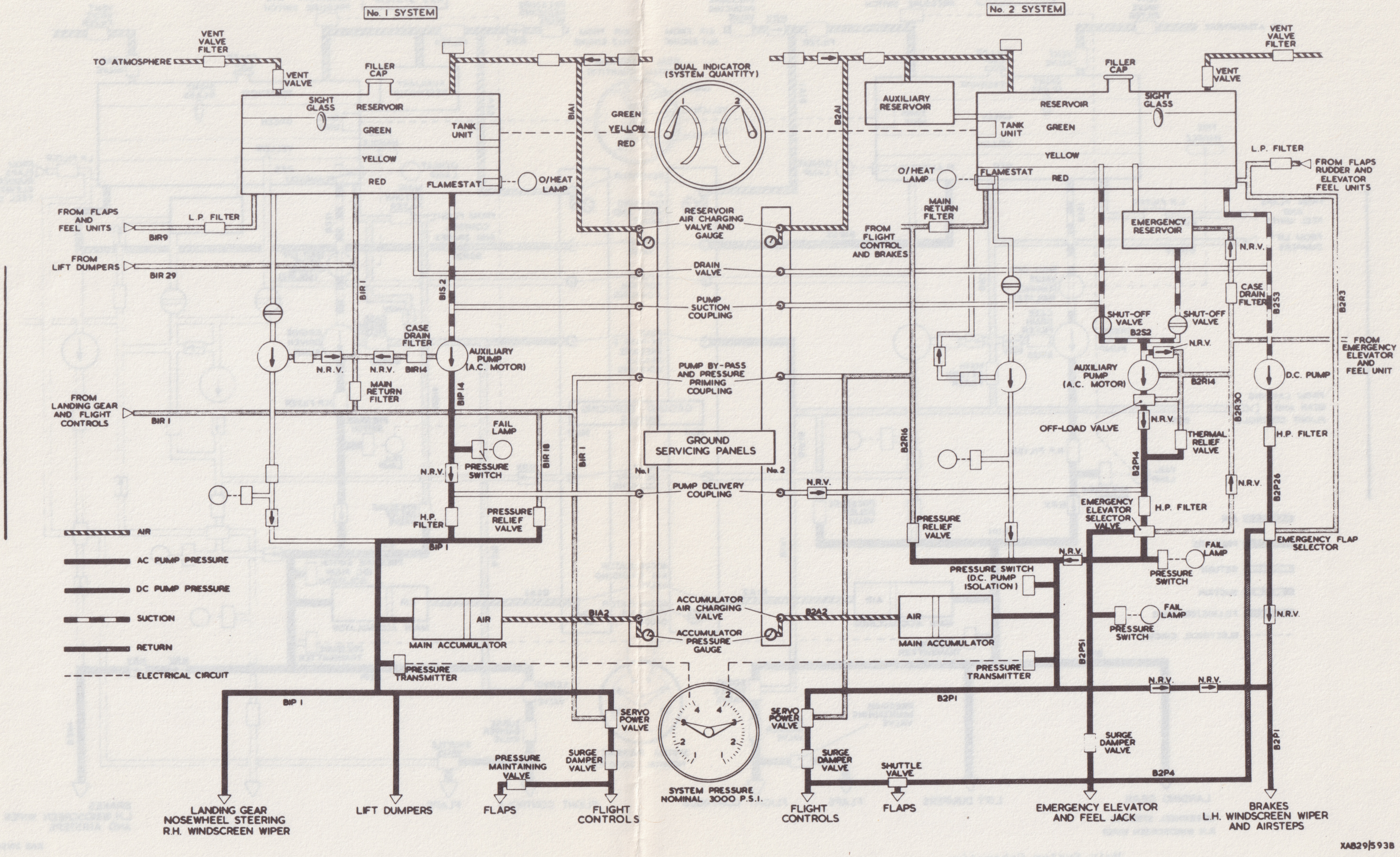
Figure 4

X028368

B082203


No I SYSTEM
No 2 SYSTEM
RESERVOIR AIR PRESSURE SWITCH
VENT VALVE FILTER
TO ATMOSPHERE
VENT VALVE
FILLER CAP
SIGHT GLASS
RESERVOIR
AUXILIARY RESERVOIR
TANK UNIT
GREEN
YELLOW
RED
FLAMESTAT
O/HEAT LAMP
FIRE HANDLE
FIRE HANDLE 2
PRESSURE REDUCING VALVE
N.R.V.
FILTER
AIR FROM No1 ENGINE
AIR FROM No2 ENGINE
DUAL INDICATOR (SYSTEM QUANTITY)
B1A1
B2A1
FROM FLAPS AND FEEL UNITS
FROM LIFT DUMPERS
L.P. FILTER
B1R9
B1R29
B1S1
B1R25
B1R1
SHUT-OFF VALVE (ENGINE ISOLATE)
CASE DRAIN FILTER
ENGINE DRIVEN PUMP
B1R23
MAIN RETURN FILTER
FROM LANDING GEAR AND FLIGHT CONTROLS
H.P. FILTER
FAIL LAMP
PRESSURE SWITCH
B1P1
PRESSURE RELIEF VALVE
B1R18
RESERVOIR
AIR CHARGING VALVE AND GAUGE
DRAIN VALVE
PUMP SUCTION COUPLING
PUMP BY-PASS & PRESSURE PRIMING COUPLING
GROUND SERVICING PANELS
No 1
No 2
PUMP DELIVERY COUPLING
ACCUMULATOR AIR CHARGING VALVE
ACCUMULATOR PRESSURE GAUGE
B1A2
B2A2
AIR
MAIN ACCUMULATOR
PRESSURE TRANSMITTER
SERVO POWER VALVE
PRESSURE MAINTAINING VALVE
SURGE DAMPER VALVE
SYSTEM PRESSURE NOMINAL 3000 P.S.I.
LANDING GEAR
NOSEWHEEL STEERING
R.H. WINDSCREEN WIPER
LIFT DUMPERS
FLAPS
FLIGHT CONTROLS
LP FILTER
FROM FLAPS RUDDER & ELEVATOR FEEL UNITS
MAIN RETURN FILTER
FROM FLIGHT CONTROL AND BRAKES
B2R25
B2S1
B2R23
B2R16
B2R1
B2P1
PRESSURE SWITCH (D.C. PUMP ISOLATION)
SHUTTLE VALVE
BRAKES
L.H. WINDSCREEN WIPER AND AIRSTEPS
AIR
PRESSURE
RETURN
SUCTION
FILLING/DRAINING
ELECTRICAL CIRCUIT
XAB 29/592B

Main System Schematic
Figure 5


No. 1 SYSTEM
No. 2 SYSTEM
TO ATMOSPHERE
VENT VALVE FILTER
VENT VALVE
FILLER CAP
SIGHT GLASS
RESERVOIR
GREEN
YELLOW
RED
TANK UNIT
FLAMESTAT
O/HEAT LAMP
DUAL INDICATOR (SYSTEM QUANTITY)
1
2
B1A1
B2A1
AUXILIARY RESERVOIR
L.P. FILTER
FROM FLAPS RUDDER AND ELEVATOR FEEL UNITS
FROM FLAPS AND FEEL UNITS
B1R9
FROM LIFT DUMPERS
B1R 29
B1R 1
B1S 2
RESERVOIR AIR CHARGING VALVE AND GAUGE
DRAIN VALVE
PUMP SUCTION COUPLING
PUMP BY-PASS AND PRESSURE PRIMING COUPLING
PUMP DELIVERY COUPLING
GROUND SERVICING PANELS
No.1
No.2
MAIN RETURN FILTER
FROM FLIGHT CONTROL AND BRAKES
EMERGENCY RESERVOIR
N.R.V.
CASE DRAIN FILTER
B1R14
AUXILIARY PUMP (A.C. MOTOR)
B1P14
SHUT-OFF VALVE
B2S2
B2S3
B2R3
FROM EMERGENCY ELEVATOR AND FEEL UNIT
D.C. PUMP
B2R14
B2R30
OFF-LOAD VALVE
THERMAL RELIEF VALVE
H.P. FILTER
FROM LANDING GEAR AND FLIGHT CONTROLS
FAIL LAMP
PRESSURE SWITCH
B1R 8
B1P1
PRESSURE RELIEF VALVE
B2R16
B2P14
B2P26
EMERGENCY ELEVATOR SELECTOR VALVE
EMERGENCY FLAP SELECTOR
PRESSURE SWITCH (D.C. PUMP ISOLATION)
ACCUMULATOR AIR CHARGING VALVE
ACCUMULATOR PRESSURE GAUGE
B1A2
B2A2
AIR
MAIN ACCUMULATOR
PRESSURE TRANSMITTER
B2P51
B2P1
SERVO POWER VALVE
SURGE DAMPER VALVE
PRESSURE MAINTAINING VALVE
SHUTTLE VALVE
B2P4
SYSTEM PRESSURE NOMINAL 3000 P.S.I.
LANDING GEAR NOSEWHEEL STEERING R.H. WINDSCREEN WIPER
LIFT DUMPERS
FLAPS
FLIGHT CONTROLS
EMERGENCY ELEVATOR AND FEEL JACK
BRAKES L.H. WINDSCREEN WIPER AND AIRSTEPS
AIR
AC PUMP PRESSURE
DC PUMP PRESSURE
SUCTION
RETURN
ELECTRICAL CIRCUIT
XA829/593B

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Auxiliary Systems Schematic
Figure 6

HYDRAULIC-SERVICING

General

This section details the servicing procedures necessary for reservoir fluid replenishment and accumulator and reservoir air charging.

YOU MUST

1. Maintain scrupulous cleanliness during servicing.
2. Observe the electrical safety precautions.
3. Use only hydraulic fluid direct from the manufacturer's container, or fluid reclaimed by a process approved by the manufacturer.
4. Observe the hydraulic fluid technical and personal safety precautions.
5. Use only a clean, dry-air supply for reservoir and accumulator air charging.

YOU MUST NOT

1. Replenish the reservoirs until the reservoir air pressure is released and the associated accumulators are completely discharged hydraulically.
2. Operate any hydraulic pump during fluid level checks or replenishment, or air charging.
3. Carry out any servicing procedures until the wheels are chocked and all landing gear ground locks are fitted.

APPROVED FLUIDS

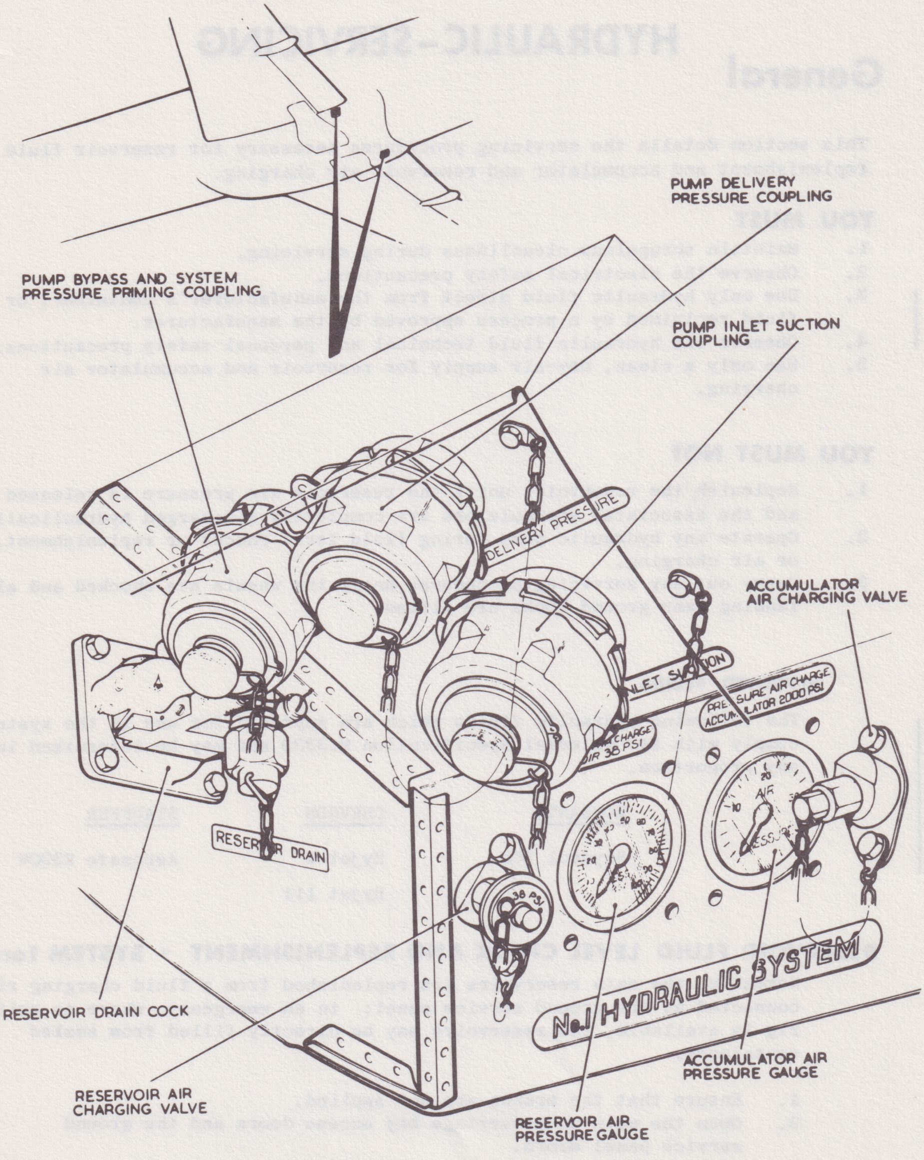
The following hydraulic fluids which are approved for use in the systems comply with BAC Material Specification M.333B and may be intermixed in any proportion.

MONSANTO	CHEVRON	STAUFFER
Skydrol 500	Hyjet W	Aerosafe 2300W
	Hyjet 111	

RESERVOIR FLUID LEVEL CHECK AND REPLENISHMENT - SYSTEM 1or2

Normally, the main reservoirs are replenished from a fluid charging rig, connected at the ground service panel; in an emergency, where no suitable rig is available, the reservoirs may be directly filled from sealed containers.

1. Ensure that the brakes are not applied.
2. Open the main undercarriage bay access doors and the ground service panel doors.
3. Connect and switch on electrical ground power (See Section 1-9-1).


PUMP DELIVERY PRESSURE COUPLING
PUMP BYPASS AND SYSTEM PRESSURE PRIMING COUPLING
PUMP INLET SUCTION COUPLING
DELIVERY PRESSURE
ACCUMULATOR AIR CHARGING VALVE
INLET SUCTION
PRESSURE AIR CHARGE ACCUMULATOR 2000 PSI
AIR CHARGE AIR 38 PSI
RESERVOIR DRAIN
38 PSI
AIR
PRESSURE
No.1 HYDRAULIC SYSTEM
RESERVOIR DRAIN COCK
ACCUMULATOR AIR PRESSURE GAUGE
RESERVOIR AIR CHARGING VALVE
RESERVOIR AIR PRESSURE GAUGE

Ground Service Panel
Figure 101

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4. Ensure that all accumulators are hydraulically discharged as follows:-
   - (a) Main accumulators (Systems 1 or 2) - pressure will dissipate through normal system leakage.
   - (b) Stand-by steering accumulator (System 1) - discharge by repeatedly depressing the solenoid of the stand-by steering selector valve.
   - (c) Brake accumulators (System 2) - discharge by repeatedly operating the foot brake pedals and parking brake lever.
5. Release the reservoir air pressure.
6. Ensure that the appropriate accumulator air pressures are correct.
7. Check that the reservoir fluid is level with the MAX mark on the sight-glass. If necessary, replenish as follows:-

   Connect the fluid charging rig to the PUMP BYPASS AND SYSTEM PRESSURE PRIMING coupling on the ground service panel. Replenish the reservoir, allowing air to escape via the filler cap, to the MAX mark on the sight-glass, disconnect the rig and refit the coupling dust cap.
8. Pressurize the reservoir with air (see below).
9. Hydraulically pressurize the system including the flight control services, using the associated a.c. pump. Check that the appropriate pointer on the instrument panel dual indicator registers at the top of the green band.
10. Switch off and disconnect electrical ground power.
11. Close the ground service panel door and the main undercarriage bay access door.

BRAKE ACTUATOR RESERVOIR REPLENISHMENT

1. Ensure that the brakes are not applied.
2. Open the radome and locate the reservoir fitted on the forward pressure bulkhead.
3. Remove the reservoir cap. and fill to within $\frac{1}{2}$ in. of the top, using hydraulic fluid from a sealed container.
4. Refit the cap, and operate the left and right-hand brake pedals separately, then in pairs.
5. Recheck the fluid level, add more fluid if necessary.
6. Close and fasten the radome.

MAIN ACCUMULATOR AIR CHARGING - SYSTEM 1 or 2

1. Ensure that the accumulator is hydraulically discharged.
2. Open the ground service panel door to gain access to the accumulator charging valve and pressure gauge.
3. Connect a clean, dry-air supply line to the charging valve, charge the accumulator to 2 000 p.s.i., indicated on the adjacent gauge.
4. Disconnect the air supply, refit the charging valve dust cap.

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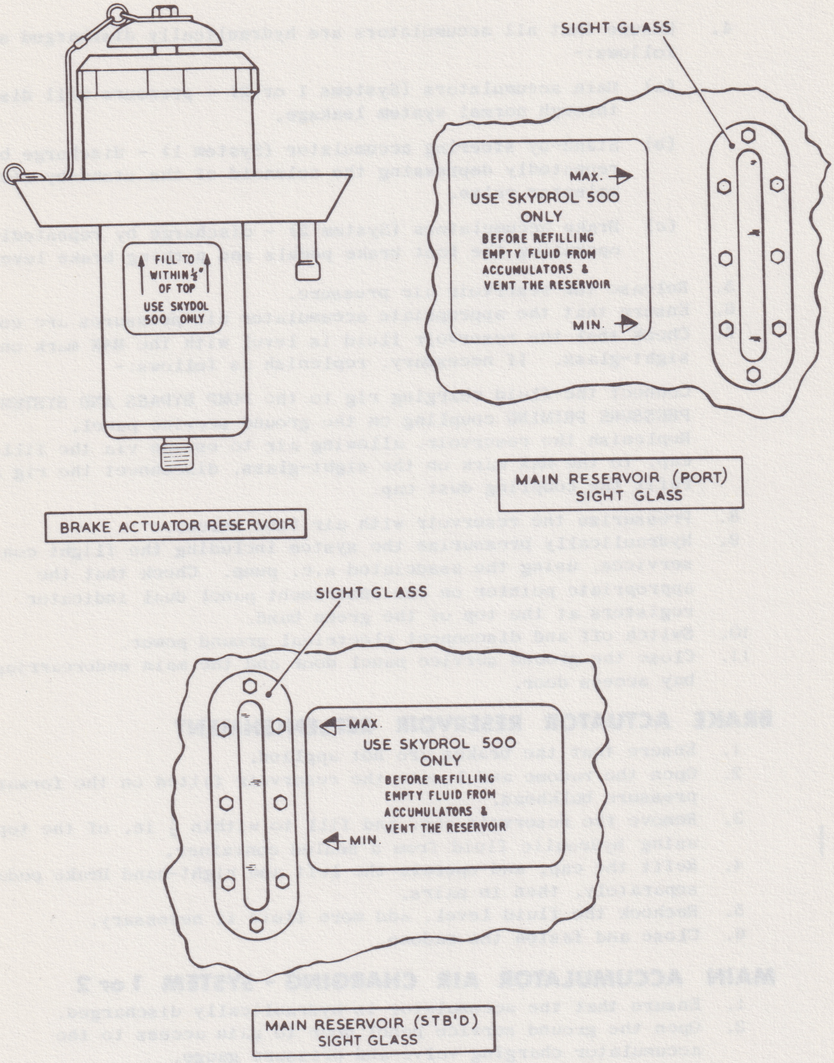
SIGHT GLASS
MAX.
USE SKYDROL 500 ONLY
BEFORE REFILLING EMPTY FLUID FROM ACCUMULATORS & VENT THE RESERVOIR
MIN.
FILL TO WITHIN ½" OF TOP
USE SKYDOL 500 ONLY
MAIN RESERVOIR (PORT) SIGHT GLASS
BRAKE ACTUATOR RESERVOIR
SIGHT GLASS
MAX.
USE SKYDROL 500 ONLY
BEFORE REFILLING EMPTY FLUID FROM ACCUMULATORS & VENT THE RESERVOIR
MIN.
MAIN RESERVOIR (STB'D) SIGHT GLASS

XAB12/139

Reservoir Sight Gauges
Figure 102

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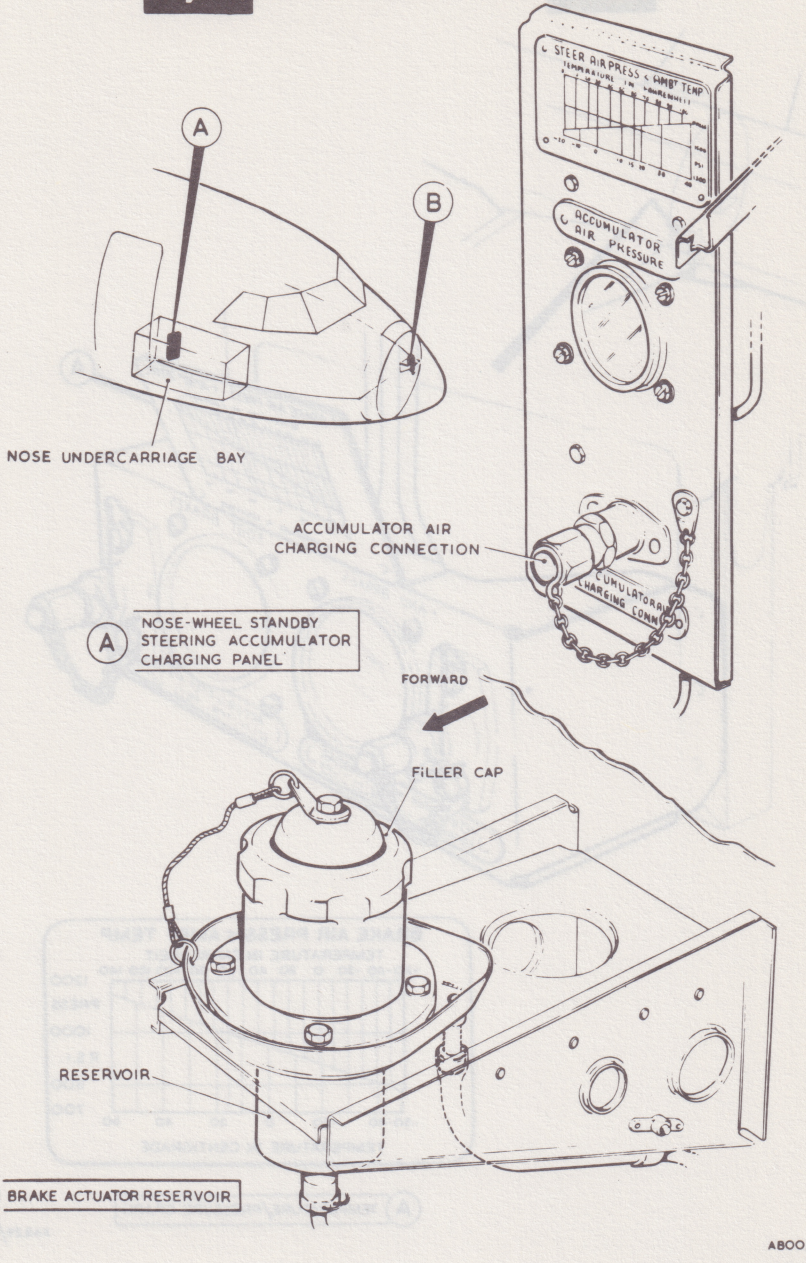
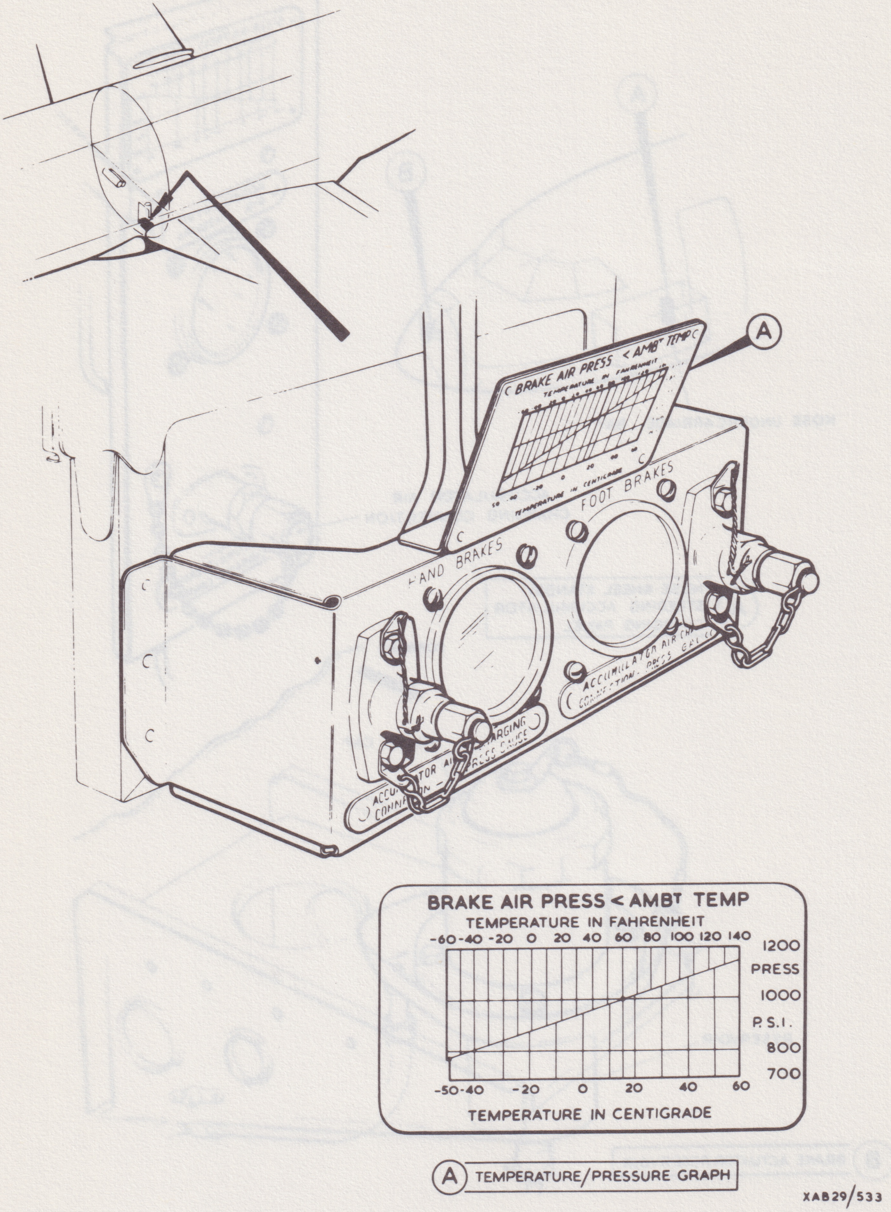

STEER AIR PRESS & AMB^T TEMP
TEMPERATURE IN FAHRENHEIT
ACCUMULATOR AIR PRESSURE
A
B
NOSE UNDERCARRIAGE BAY
ACCUMULATOR AIR CHARGING CONNECTION
ACCUMULATOR CHARGING CONN
A NOSE-WHEEL STANDBY STEERING ACCUMULATOR CHARGING PANEL
FORWARD
FILLER CAP
RESERVOIR
B BRAKE ACTUATOR RESERVOIR
ABOO/2752A

Standby Steering Accumulators - Air Charging Panel and Brake Reservoir
Figure 103


A
BRAKE AIR PRESS < AMBT TEMP
HAND BRAKES
FOOT BRAKES
ACCUMULATOR AIR CHARGING
CONNECTION PRESS GAUGE
BRAKE AIR PRESS < AMBT TEMP
TEMPERATURE IN FAHRENHEIT
-60 -40 -20 0 20 40 60 80 100 120 140
1200
PRESS
1000
P.S.I.
800
700
-50 -40 -20 0 20 40 60
TEMPERATURE IN CENTIGRADE
A TEMPERATURE/PRESSURE GRAPH
XAB29/533

Brake Accumulator Air Charging Panel
Figure 104

BRAKE SYSTEM ACCUMULATORS AIR CHARGING

1. Remove the brake accumulator servicing access panel.
2. Hydraulically depressurize the brake accumulators by repeatedly operating the foot brake pedals and parking brake lever.
3. Connect a clean, dry-air supply line to each charging valve in turn. Charge each accumulator to 1,000 p.s.i. indicated on the associated gauge, or to the equivalent pressure stated on the adjacent temperature/pressure graph for the ambient temperature.
4. Disconnect the air supply, refit the charging valve dust caps.
5. Disconnect the air supply, refit the dust caps, close the access doors.

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STANDBY STEERING ACCUMULATOR AIR CHARGING

1. Open the nose undercarriage bay forward access doors, to gain access to the accumulator charging panel.
2. Hydraulically depressurize the accumulator by repeatedly depressing the solenoid of the standby steering selector valve.
3. Remove the dust cap and connect a clean dry-air supply line to the charging valve. Charge the accumulator to 1,500 p.s.i., indicated on the associated gauge, or to the equivalent pressure stated on the temperature/pressure graph for the ambient temperature.
4. Disconnect the air supply, refit the dust cap, close the access doors.

MAIN RESERVOIR AIR CHARGING - SYSTEM 1or2

1. Ensure that all accumulators are hydraulically discharged.
2. Open the ground service panel access door. Remove the guard and dust cap and connect a clean, dry-air supply line to the reservoir charging valve.
3. Charge the reservoir to 38 p.s.i., indicated on the adjacent pressure gauge.
4. Disconnect the air supply, refit the dust cap and guard, close the access panel.

ICE AND RAIN

General

The aircraft is provided with both visual and automatic ice detection equipment. Vulnerable areas are heated, either electrically or with hot air supplied by the pneumatic system, to prevent or disperse ice formation. De-misting equipment is fitted to the flight deck side windows and the passenger cabin windows. The windscreens are equipped with hydraulically operated wipers, and a rain repellant system may be fitted.

ICE DETECTION

Mounted on the left side of the aircraft nose is the automatic ice detector, comprising a small flexibly-mounted electric motor, rotating a serrated spindle in close proximity to a fixed knife-edge cutter. Ice formed on the spindle is shaved off by the cutter, producing a torque reaction which moves the motor sufficiently to operate a micro-switch, completing the circuit to the ICE WARNING lamp and master warning system on the flight deck. The detector operates continuously while the aircraft is in flight, the power supply being controlled by a weight switch fitted to the main undercarriage.

A visual ice detector is fitted below the captain's DV window within the normal field of vision, and comprises a short aerofoil section mast incorporating a heating element, and mounted on a base which houses a lamp and reflector for viewing the detector in darkness. The unit is controlled by a three-position switch on panel E. Ice observed forming on the mast is dispersed by moving the switch to HEAT, which actuates both the lamp and the heating element. The alternate switch positions are LIGHT, which operates the lamp only, and OFF.

Illumination of the wing leading edges and engine intakes, to permit inspection for ice formation in darkness, is provided by lamps fitted flush in the forward fuselage and wing trailing edges.

ICE PROTECTION

Pitot Heads

Electrical heating elements are incorporated in the fuselage-mounted pitot heads and stall protection sensors, and in pitot heads mounted on the fin bullet. The power supply is controlled by the PITOT HEATER switches on panel E; current taken by the pitot head heaters is indicated by adjacent ammeters. The stall protection sensors have HEATERS FAIL warning lights on the roof panel. Power supply to the left fuselage pitot head (captain's instruments) is automatically maintained by the aircraft batteries, in event of complete generated power failure.

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Water System and Drains

The entire length of water supply and forward waste pipelines are wrapped with electrical heating elements, the element temperatures being automatically controlled by two thermostats clamped to the pipelines.

The two water drain outlets mounted on the underside of the fuselage incorporate electrical heating elements; to protect these overheating when the aircraft is on the ground, a lower voltage is directed to the elements by a weight switch fitted on the main undercarriage.

Windscreens

The main windscreens are electrically-heated through a transparent conductive film interposed between the panel laminations. Each panel is monitored by two temperature-sensing elements fitted within the laminations and connected to independent control equipment. Windscreen heating is controlled by a common LOW OFF HIGH switch mounted on panel E, together with overheat and underheat warning lights for each panel. If normal heating fails to prevent icing, increased voltage can be passed through the panels by moving the selector switch from LOW to HIGH.

Airfoil

The airfoil anti-icing system is provided with duplicated supplies of hot air by the pneumatic system. Each supply passes through an electrically-operated shut-off valve and a non-return valve, then enters a common distribution duct. In the event of an engine shut-down or a supply failure the air mass flow is reduced by 30%,but anti-ice protection remains symmetrical and the non-return valves prevent air spilling from one supply system to the other.

The distribution ducts pass the hot air into perforated diffuser tubes fitted within the wing, fin and tailplane leading edges. To prevent ice of a hazardous size being shed into the engine intakes, distribution of air along the wings is graded to provide the inner ten feet with a more intense heat. Hot air, bled from the tailplane supply, provides additional heating for nose and flanks of the bullet fairings, to prevent formation of ice interfering with tailplane movement.

The hot air supplies are exhausted to atmosphere through vents on the underside of wing leading-edges, louvres on each side of the fin, and vents at each tailplane tip.

Mounted on the ANTI-ICE SYSTEM section of panel E are four switches paired as SYSTEM 1 and SYSTEM 2, and pressure indicators. Each switch controls a supply shut-off valve, and the indicators read ON when duct supply pressure is satisfactory.

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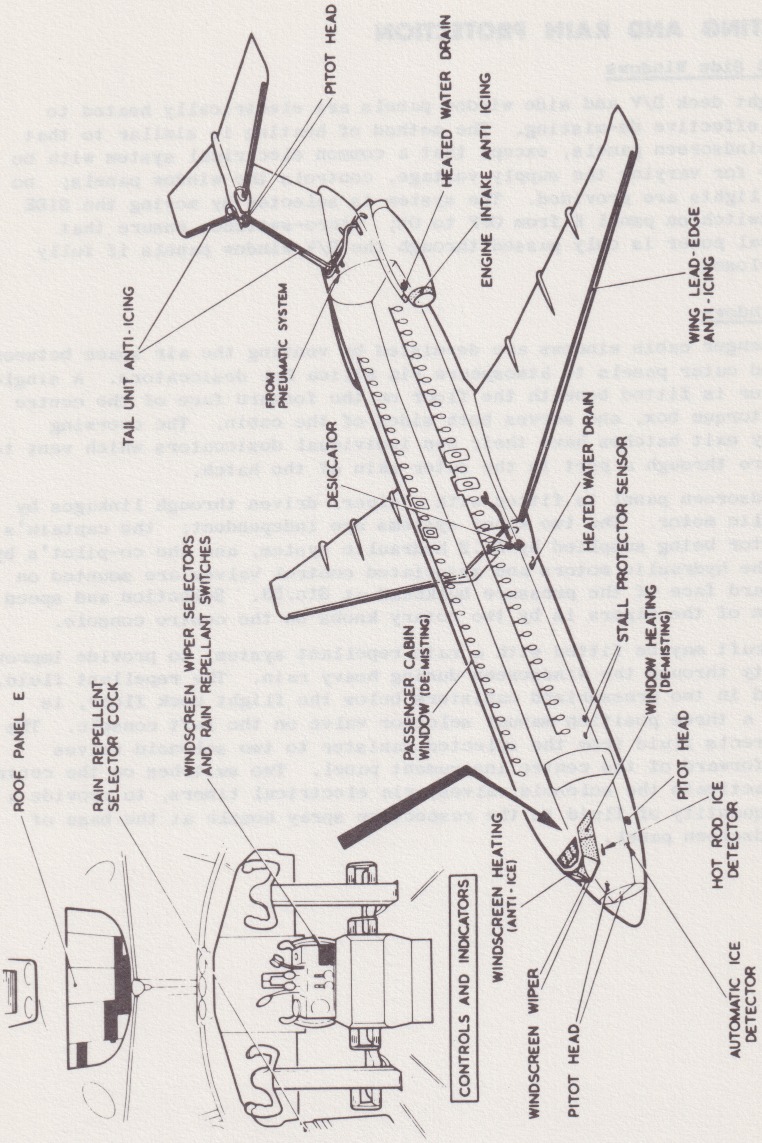

PITOT HEAD
HEATED WATER DRAIN
ENGINE INTAKE ANTI ICING
WING LEAD-EDGE ANTI-ICING
TAIL UNIT ANTI-ICING
FROM PNEUMATIC SYSTEM
DESICCATOR
HEATED WATER DRAIN
STALL PROTECTOR SENSOR
WINDOW HEATING (DEMISTING)
PITOT HEAD
HOT ROD ICE DETECTOR
PASSENGER CABIN WINDOW (DE-MISTING)
WINDSCREEN WIPER SELECTORS AND RAIN REPELLANT SWITCHES
RAIN REPELLENT SELECTOR COCK
ROOF PANEL E
CONTROLS AND INDICATORS
WINDSCREEN HEATING (ANTI-ICE)
WINDSCREEN WIPER
PITOT HEAD
AUTOMATIC ICE DETECTOR

XAB30/385

G.A. of Ice and Rain Protection
Figure 1

DE-MISTING AND RAIN PROTECTION

D.V. and Side Windows

The flight deck D/V and side window panels are electrically heated to provide effective de-misting. The method of heating is similar to that of the windscreen panels, except that a common electrical system with no facility for varying the supply voltage, controls the window panels; no warning lights are provided. The system is selected by moving the SIDE WINDOW switch on panel E from OFF to ON; micro-switches ensure that electrical power is only passed through the D/V window panels if fully locked closed.

Cabin Windows

All passenger cabin windows are de-misted by venting the air space between inner and outer panels to atmosphere via Silica Gel desiccators. A single desiccator is fitted beneath the floor on the forward face of the centre section torque box, and serves both sides of the cabin. The overwing emergency exit hatches have their own individual desiccators which vent to atmosphere through a port in the outer skin of the hatch.

Each windscreen panel is fitted with a wiper, driven through linkages by a hydraulic motor. The two wiper systems are independent; the captain's wiper motor being supplied by No.2 hydraulic system, and the co-pilot's by No.1. The hydraulic motors and associated control valves are mounted on the forward face of the pressure bulkhead at Stn.53. Selection and speed variation of the wipers is by two rotary knobs on the centre console.

The aircraft may be fitted with a rain repellant system, to provide improved visibility through the windscreen during heavy rain. The repellant fluid, contained in two pressurized canisters below the flight deck floor, is piped to a three position manual selector valve on the left console. The valve directs fluid from the selected canister to two solenoid valves mounted forward of the centre instrument panel. Two switches on the centre console activate the solenoid valves, via electrical timers, to provide a metered quantity of fluid to the respective spray nozzle at the base of each windscreen panel.

ICE AND RAIN-SERVICING

DESICCATORS

Access to the main desiccators, mounted on the front of the centre section torque box, is through panels in the underwing fairing.

On the overwing exit hatches, access is by removing a small furnishing panel.

Renew desiccant crystals when their colour has changed to pink, indicating 'life' expiry. Renew also the cotton wool pad. Use Silica Gel (Spec.CS2380). Serviceable crystals are blue.

Silica Gel crystals can be restored to a serviceable condition by carefully drying.

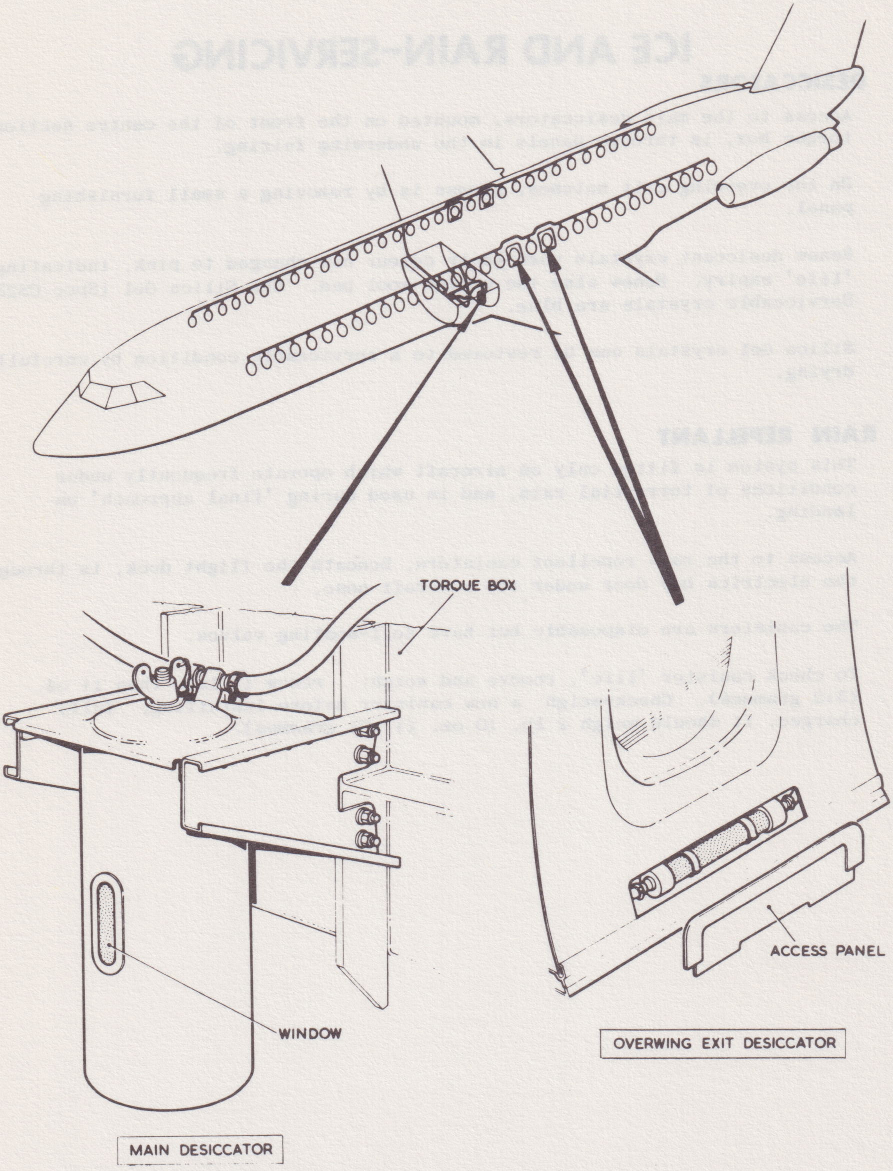
RAIN REPELLANT

This system is fitted only on aircraft which operate frequently under conditions of torrential rain, and is used during 'final approach' on landing.

Access to the rain repellant canisters, beneath the flight deck, is through the electrics bay door under the aircraft nose.

The canisters are disposable but have self-sealing valves.

To check canister 'life', remove and weigh; renew if less than 11 oz. (312 grammes). Check-weigh a new canister before installing; fully charged, it should weigh 2 lb. 10 oz. (1,191 grammes).


TORQUE BOX
WINDOW
MAIN DESICCATOR
ACCESS PANEL
OVERWING EXIT DESICCATOR

Desiccators
Figure 101

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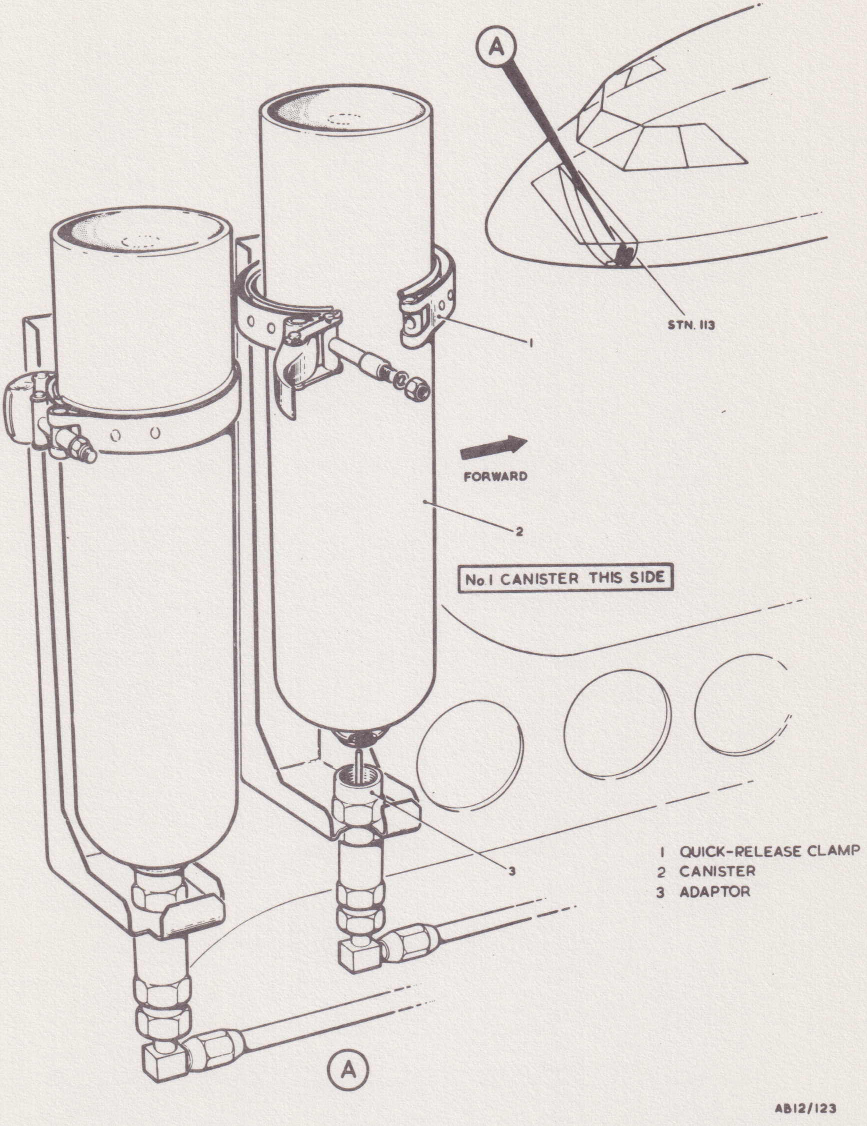
B06[illegible]266


A
STN. 113
1
FORWARD
2
No.1 CANISTER THIS SIDE
3
1 QUICK-RELEASE CLAMP
2 CANISTER
3 ADAPTOR
A
AB12/123

Rain Repellant Canisters

Figure 102

LANDING GEAR

General

The tricycle landing gear comprises twin-wheel nose and main undercarriage units which normally retract and extend under hydraulic power.

Control is by a lever on the right instrument panel.

The undercarriage bays are unpressurized and enclosed by doors, totally when the gear is retracted, and partially when extended.

When retracted, the nose undercarriage is retained by a mechanical uplock; the main undercarriages have no uplocks but are retained by their large inner doors which engage door uplocks when closed. Hydraulic sequencing unlocks and opens these doors before, and closes them after retraction and extension of the undercarriage.

A 'free-fall' system provides for emergency lowering of the undercarriage, and is used also for opening the main undercarriage inner doors to allow access for servicing and maintenance (see overleaf).

Control is by a lever inside the right console.

BRAKES

Hydraulic brakes are fitted to each main wheel, two independent control systems being provided; the foot-operated system incorporating an anti-skid device, and a hand-operated system which can be used for parking. Some aircraft are equipped with brake cooling fans (see 'Servicing' Fig.101A).

STEERING

Nose wheel steering is hydraulically-powered, control of this being from the rudder pedals or from handwheels on either side console.

The pedals give control through 7 deg. either side of the aircraft centre line, and the handwheels through 78 deg. either side of the centre line.

POWER SOURCE

Hydraulic power for normal undercarriage retraction/extension and nosewheel steering, is supplied from No.1 system.

Brakes are supplied from No.2 system.

GRAVEL DEFLECTORS

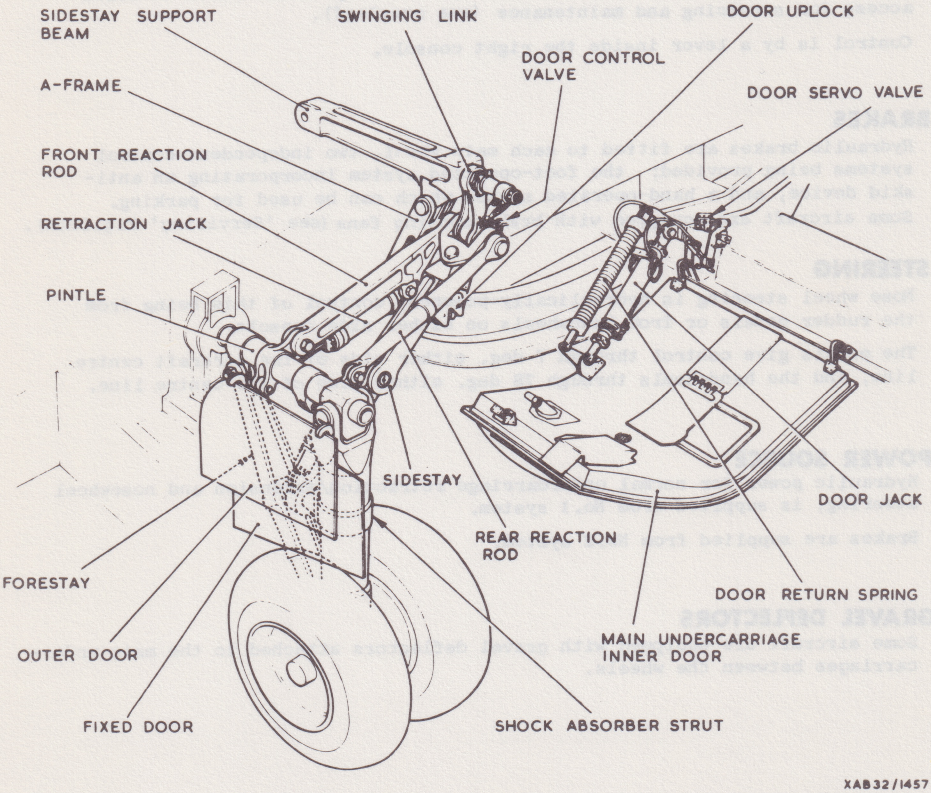
Some aircraft are equipped with gravel deflectors attached to the main undercarriages between the wheels.

OPENING MAIN INNER DOORS

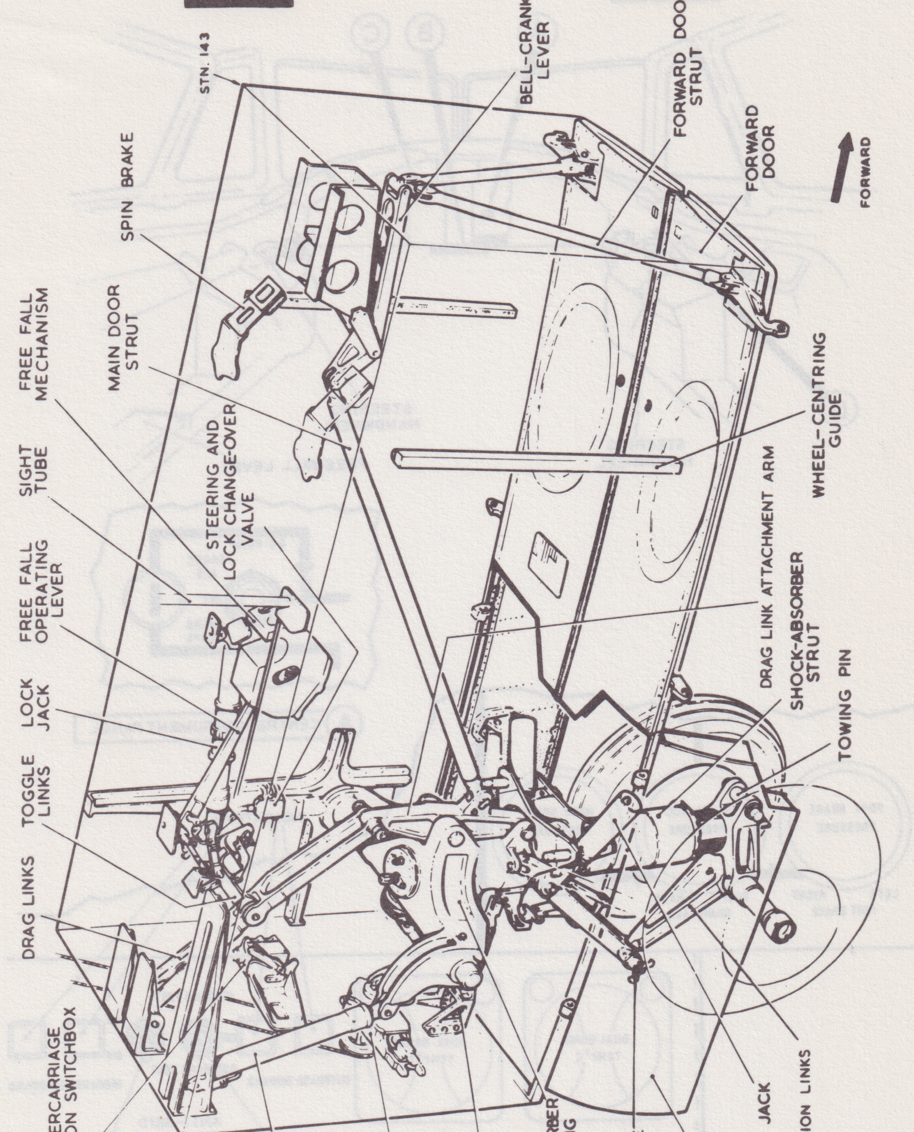
To open the main undercarriage inner doors when required for servicing etc:-

1. Ensure that the areas beneath the doors are clear of obstruction, and position a man to maintain this.
2. Open the access panel in the right console and operate the free-fall lever by first squeezing its locking lever, then pulling upward. Release the locking lever to lock when fully up.
3. Fit locks (Part No.AB94A2209) to each door jack.

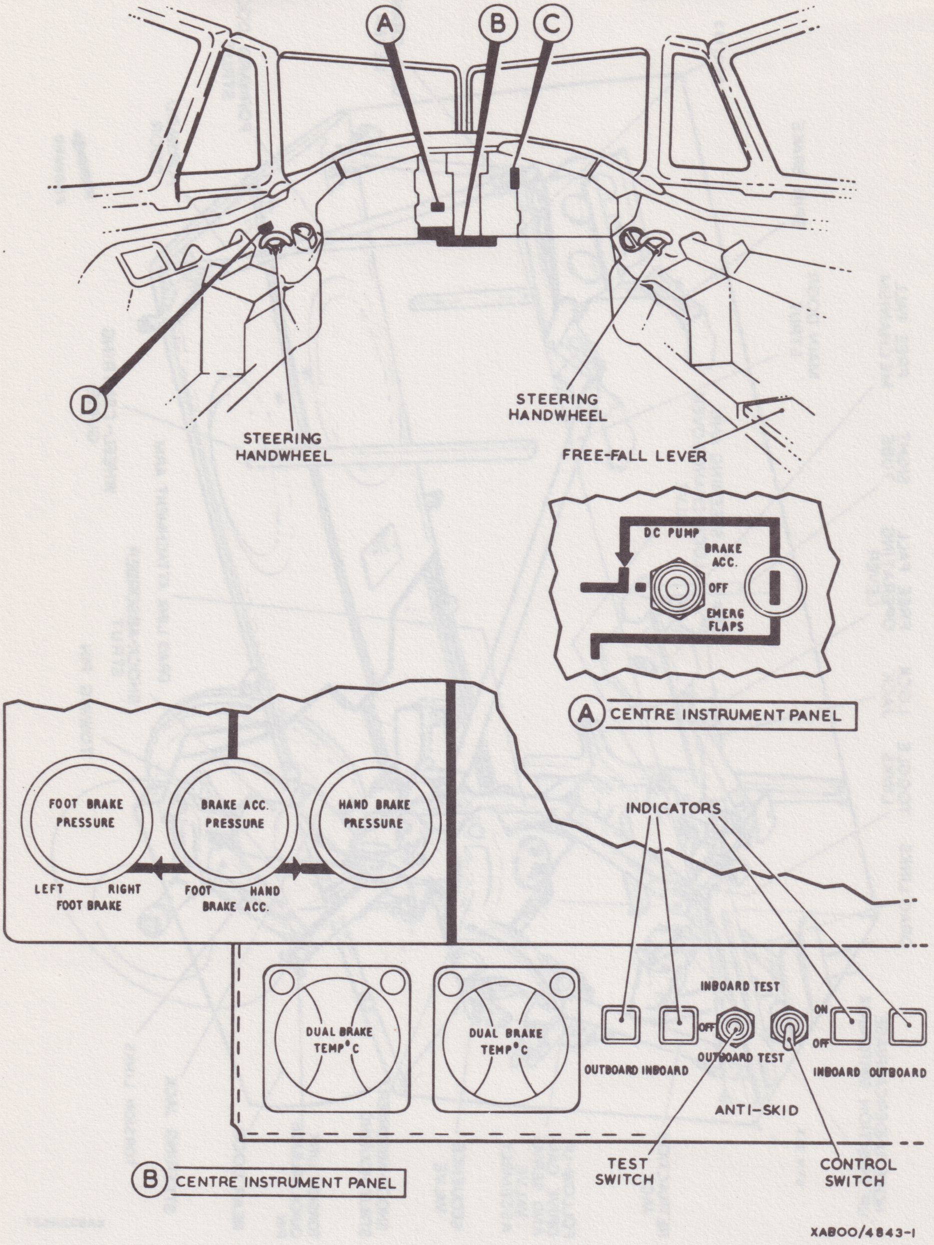
The doors are closed by removing the locks and, with hydraulics on, resetting the free-fall lever.


SIDESTAY SUPPORT BEAM
SWINGING LINK
DOOR UPLOCK
DOOR CONTROL VALVE
DOOR SERVO VALVE
A-FRAME
FRONT REACTION ROD
RETRACTION JACK
PINTLE
SIDESTAY
DOOR JACK
REAR REACTION ROD
FORESTAY
DOOR RETURN SPRING
MAIN UNDERCARRIAGE INNER DOOR
OUTER DOOR
FIXED DOOR
SHOCK ABSORBER STRUT
XAB32/1457

Main Undercarriage
Figure 1


STN. 143
BELL-CRANK LEVER
FORWARD DOOR STRUT
FORWARD DOOR
FORWARD
SPIN BRAKE
FREE FALL MECHANISM
MAIN DOOR STRUT
WHEEL-CENTRING GUIDE
SIGHT TUBE
STEERING AND LOCK CHANGE-OVER VALVE
FREE FALL OPERATING LEVER
DRAG LINK ATTACHMENT ARM
SHOCK-ABSORBER STRUT
LOCK JACK
TOWING PIN
TOGGLE LINKS
DRAG LINKS
NOSE UNDERCARRIAGE 'UP' POSITION SWITCHBOX
STN. 213
RETRACTION JACK
FOLLOW-UP DRIVE CAM AND SERVO VALVE ASSEMBLY
SEQUENCE VALVE
SHOCK-ABSORBER STRUT HOUSING
TORSION LINK QUICK RELEASE PIN
REAR DOOR
STEERING JACK
TORSION LINKS
XAB32/1627

Nose Undercarriage
Figure 2


A
B
C
D
STEERING HANDWHEEL
STEERING HANDWHEEL
FREE-FALL LEVER
DC PUMP
BRAKE ACC.
OFF
EMERG FLAPS
A CENTRE INSTRUMENT PANEL
FOOT BRAKE PRESSURE
BRAKE ACC. PRESSURE
HAND BRAKE PRESSURE
LEFT
RIGHT
FOOT BRAKE
FOOT
HAND
BRAKE ACC.
INDICATORS
DUAL BRAKE TEMP°C
DUAL BRAKE TEMP°C
INBOARD TEST
OFF
OUTBOARD TEST
ON
OFF
OUTBOARD INBOARD
INBOARD OUTBOARD
ANTI-SKID
TEST SWITCH
CONTROL SWITCH
B CENTRE INSTRUMENT PANEL
XAB00/4843-1

Typical Controls and Indicators (1) - (See also Fig.4)

Figure 3

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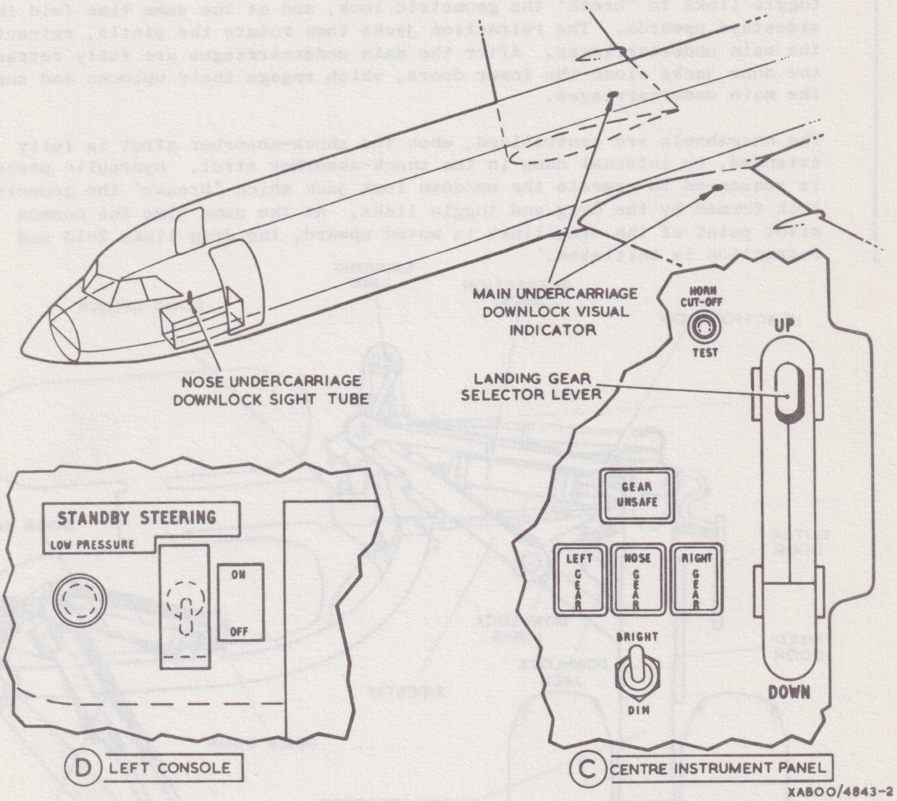

MAIN UNDERCARRIAGE DOWNLOCK VISUAL INDICATOR
NOSE UNDERCARRIAGE DOWNLOCK SIGHT TUBE
HORN CUT-OFF
TEST
UP
LANDING GEAR SELECTOR LEVER
STANDBY STEERING
LOW PRESSURE
ON
OFF
GEAR UNSAFE
LEFT GEAR
NOSE GEAR
RIGHT GEAR
BRIGHT
DIM
DOWN
D LEFT CONSOLE
C CENTRE INSTRUMENT PANEL
XABOO/4843-2

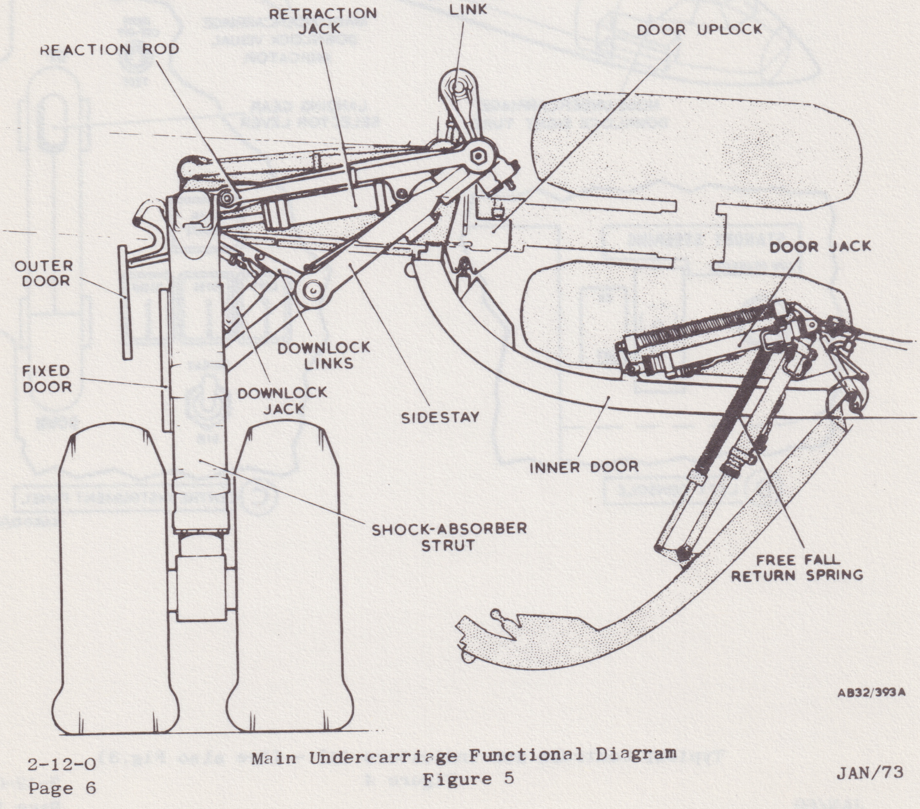
Typical Controls and Indicators (1) - (See also Fig.3)
Figure 4

Operation

RETRACTION

With System No.1 pressurized and the selector lever moved to UP, the brakes are automatically applied. Hydraulic pressure releases the main undercarriage inner door uplocks and the door jacks extend, opening the doors. When both doors are fully open, sequence valves direct the hydraulic pressure to the down-lock jacks, the down-locks disengage and the down-lock jacks fold the toggle links to 'break' the geometric lock, and at the same time fold the sidestays upwards. The retraction jacks then rotate the pintle, retracting the main undercarriages. After the main undercarriages are fully retracted, the door jacks close the inner doors, which engage their uplocks and support the main undercarriages.

The nosewheels are centralized, when the shock-absorber strut is fully extended, by internal cams in the shock-absorber strut. Hydraulic pressure is sequenced to operate the up/down lock jack which 'breaks' the geometric lock formed by the drag and toggle links. At the same time the common pivot point of the drag links is moved upward, the drag links fold and retraction is initiated.


SWINGING LINK
RETRACTION JACK
REACTION ROD
DOOR UPLOCK
DOOR JACK
OUTER DOOR
DOWNLOCK LINKS
FIXED DOOR
DOWNLOCK JACK
SIDESTAY
INNER DOOR
SHOCK-ABSORBER STRUT
FREE FALL RETURN SPRING
AB32/393A

Main Undercarriage Functional Diagram
Figure 5

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The hydraulic pressure is directed to the retraction jack by a steering centre valve when the wheels have centralized, the retraction jack extends and the nose undercarriage is retracted, and is held in the retracted position by a geometric lock imposed on the toggle links.

The GEAR UNSAFE warning light on the centre instrument panel comes on when the undercarriage selector lever is unlatched prior to being moved to UP. As the main and nose undercarriage downlocks 'break' and retraction is initiated, the three green lights LEFT GEAR, NOSE GEAR and RIGHT GEAR go out. When the landing gear is fully retracted and each main undercarriage inner door uplock is engaged, the UNSAFE light goes out, (providing the selector lever is latched) the brakes are released and the undercarriage hydraulic system depressurized.

EXTENSION

With System No.1 pressurized and the selector lever in the DOWN position, hydraulic pressure releases the inner door uplocks and the door jacks extend to open the inner doors. When the doors are fully open, the hydraulic pressure is sequenced to the down side of the retraction jacks which in turn rotate the pintles and extend the landing gear. Spring-loading on the downlock jacks reimposes the geometric lock in the toggle links. When the landing gear is locked down, hydraulic pressure is again sequenced to close the inner doors and engage the door uplocks.

Simultaneously, hydraulic pressure is directed from the 'lower' line to the down side of the nose undercarriage retraction jack via the steering and lock change-over valve to 'break' the uplock. The jack extends the nose undercarriage and when fully extended a geometric lock is imposed on the toggle links.

The GEAR UNSAFE warning light comes on when the undercarriage selector is moved to DOWN and latched. When the undercarriages are fully extended and the downlock on each undercarriage engages, the green light in each of the three indicators on the centre instrument panel comes on. The main undercarriage inner doors then close and when the door uplock is engaged the GEAR UNSAFE light goes out.

STEERING

When the nose undercarriage is fully locked down the steering and lock change-over valve is mechanically actuated to allow pressure from the 'lower' line to pass to the steering control valve.

Manual movement of either handwheel is transmitted via cables and a feedback assembly to move the steering control valve from the neutral position, thus connecting one side of each steering jack to return. Pressure present on the other side of each jack causes the jacks to rotate the shock-absorber strut in the strut housing. The subsequent movement of the nosewheels drives the follow up cables, linkage and the feedback mechanism, to restore the steering control valve towards the neutral position.

With the steering handwheel held stationary, the displacement of the control line valve from neutral is maintained. When the handwheel is released the control valve returns to neutral under influence of a centring spring leaving the nosewheels free to castor.

Rudder 'fine' steering is limited to 7 degrees on each side of the aircraft centre line with full rudder delection, and is only operative with the landing gear selected down and the nose strut compressed. With the landing gear lowered, a clutch is operated hydraulically, connecting the rudder pedal linkage to the steering cables. Thus steering is achieved through a limited range from the rudder pedals using the normal steering system. Movement of the steering handwheel overrides the signals from the rudder pedals.

STANDBY STEERING

The standby steering is intended for use only when landing the aircraft with the free fall system selected or when pressure is not available from No.1 hydraulic system.

During all normal operations, the standby steering must be switched off.

The standby steering supply should be selected after the nose landing gear has been locked down, and prior to landing. Following a selection of the standby steering supply, power is not available at the steering cylinders until the main gear shock-absorber struts are compressed.

The standby steering accumulator is normally hydraulically charged by System No.1. With the standby steering switch in the ON position and the main undercarriage weight-switch relays actuated, a selector valve is energized to connect the accumulator through the control valve to the steering jacks and steering is effected by normal operation. On completion of landing the standby steering must be switched off.

An amber warning light at the side of the switch comes on when pressure in the accumulator falls to 2,000 p.s.i.

FREE FALL

When the free fall lever is pulled upward, the nose undercarriage lock and the main undercarriage door locks are released allowing the undercarriage to lower under its own weight.

The landing gear control valve is mechanically operated, irrespective of the selector lever position, and the pressure supply is blanked off. The 'raise' and 'lower' lines are connected to the return line and fluid is released from the main retraction jacks allowing the landing gear to lower freely. The wheels push the inner doors open and the doors remain partially open after the landing gear locks down, leaving sufficient ground clearance.

The position of the selector lever does not affect free fall operation but should be left in the DOWN position and must be in this position before the free fall lever is reset.

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BRAKES

When the rudder foot pedals are depressed, at either pilot's position, master cylinders transmit the movement by servo pressure to actuate a brake pressure control valve which regulates pressure delivery to the brake units and provides for differential braking.

With System No.2 inoperable the foot brake accumulator provides one full braking stop with anti-skid units operating.

The anti-skid system is an integrated mechanical-electrical-hydraulic system which controls the aircraft hydraulic brakes to obtain the maximum aircraft retardation, under all runway conditions, without skidding.

Mounted within each wheel axle and driven by the wheel, is a wheel speed transducer which provides a signal proportional to wheel speed. This signal is fed to the control shield. A dual pressure control valve feeds braking pressure to each main wheel in conjunction with the control shield to control excessive brake pressure and to provide wheel protection with optimum braking control.

Thermo-couples connected into the brake units, give indication of wheelbrake temperatures through brake temperature gauges.

When a hand-brake handle is pulled, a cable-operated control valve is actuated and permits an equal pressure to be applied to the four brake units. For parking, the left handbrake handle is pulled and turned-to-lock in the'brakes applied'position.

On landing gear retraction, an auto-brake jack is pressurized and actuates the cable-operated control valve permitting a pressure delivery to the main wheel brakes.

The handbrake accumulator provides a minimum of six full brake applications with System No.2 inoperable.

WEIGHT SWITCH-OPERATED CIRCUITS

Compression of the shock-absorber strut operates the weight-switch-box and the following circuits are affected:-

1. Landing gear indication and lock control
2. Stall warning system (Isolates stick-push, stick shake and auto-ignition)
3. Galley supplies
4. Air conditioning ground cooling fan
5. Ice detector
6. Water system anti-icing
7. Configuration warning

8. Generator cooling
9. Standby steering and LP warning
10. Elevator isolate (Permits elevator gust damping on the ground)
11. Anti-skid system
12. Flight data recorder (On some aircraft, for example Model 501, the flight data recorder is not controlled through the weight-circuits, but manually switched from the flight deck).
13. Airfoil anti-ice
14. AC hydraulic pumps
15. Lift dumpers
16. Flight voice recorder
17. Engine start and CSDS control.

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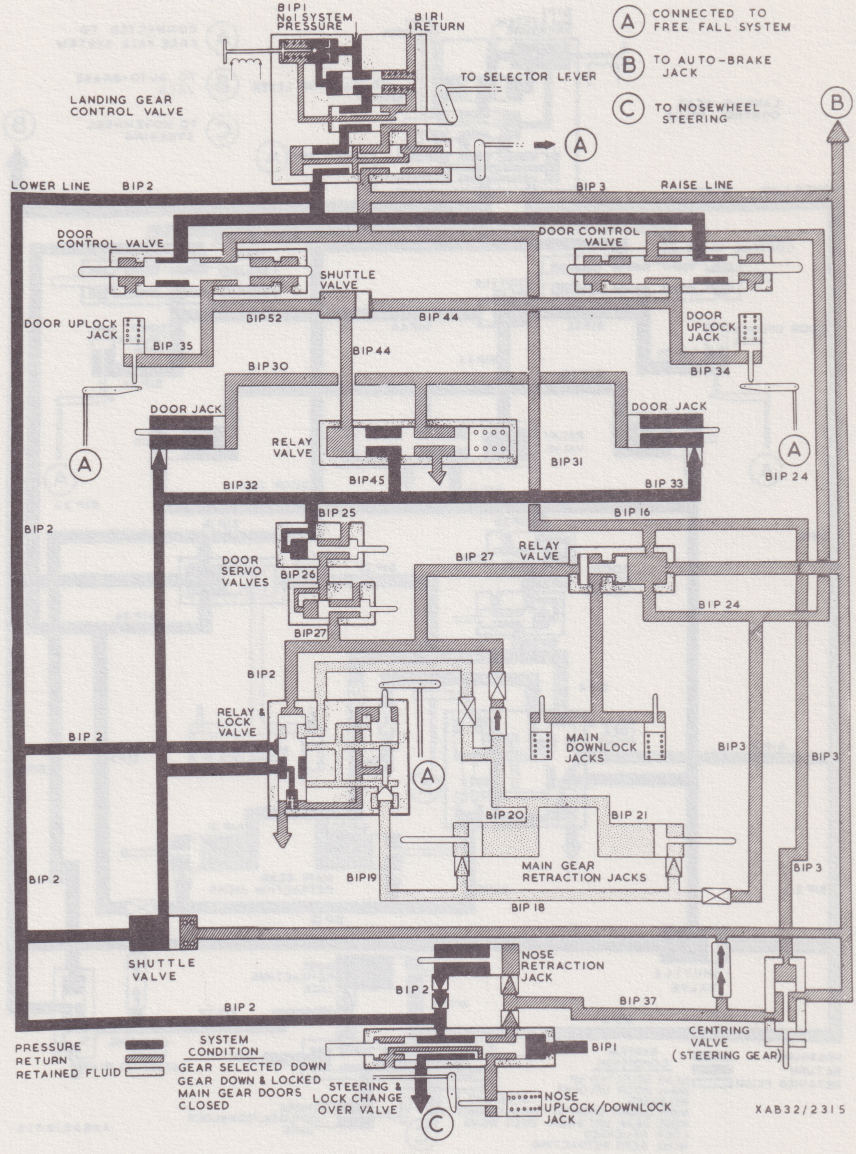
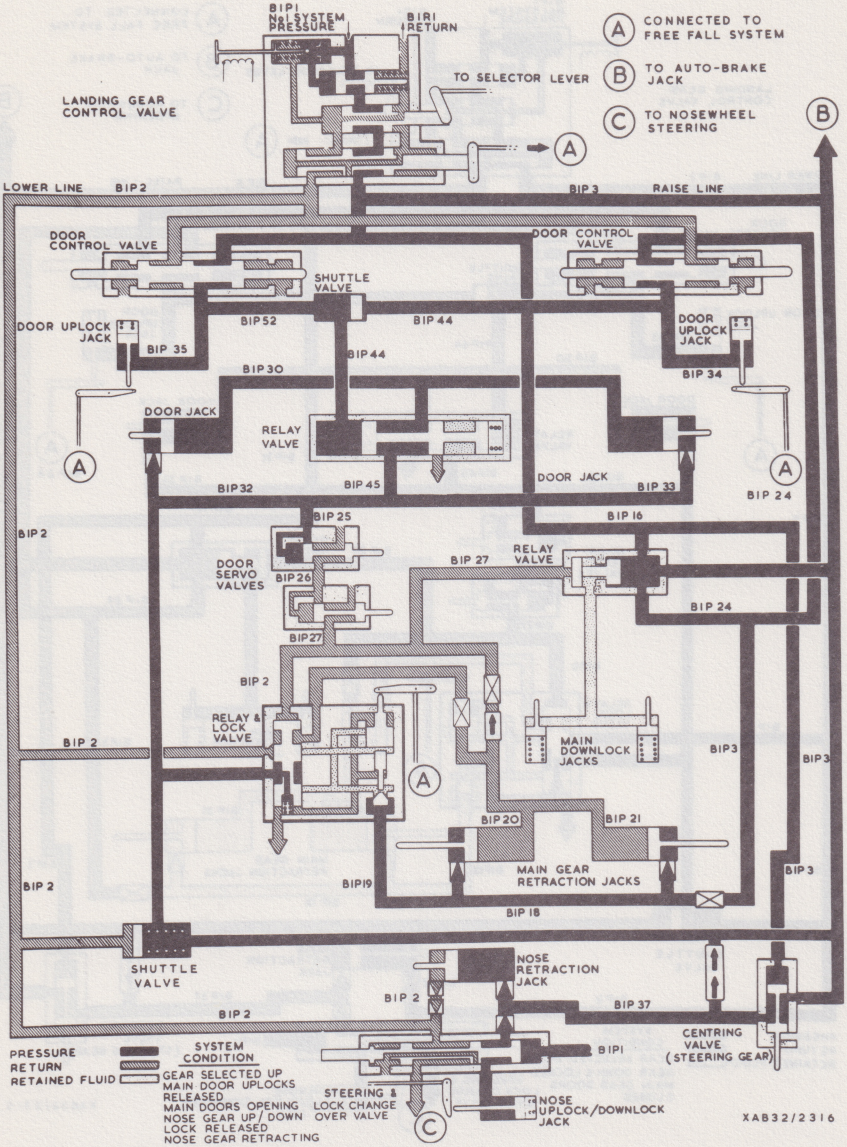

BIP1 No.1 SYSTEM PRESSURE
BIR1 RETURN
LANDING GEAR CONTROL VALVE
TO SELECTOR LEVER
A CONNECTED TO FREE FALL SYSTEM
B TO AUTO-BRAKE JACK
C TO NOSEWHEEL STEERING
B
A
LOWER LINE
BIP2
BIP3
RAISE LINE
DOOR CONTROL VALVE
DOOR CONTROL VALVE
SHUTTLE VALVE
BIP52
BIP44
DOOR UPLOCK JACK
BIP 35
DOOR UPLOCK JACK
BIP 34
BIP44
BIP30
DOOR JACK
DOOR JACK
RELAY VALVE
A
A
BIP31
BIP32
BIP45
BIP 33
BIP 24
BIP 2
BIP 25
BIP 16
DOOR SERVO VALVES
BIP26
BIP 27
RELAY VALVE
BIP 24
BIP27
BIP2
RELAY & LOCK VALVE
MAIN DOWNLOCK JACKS
BIP 2
A
BIP3
BIP3
BIP 20
BIP 21
MAIN GEAR RETRACTION JACKS
BIP19
BIP 18
BIP 3
BIP 2
SHUTTLE VALVE
NOSE RETRACTION JACK
BIP 2
BIP 2
BIP 37
CENTRING VALVE (STEERING GEAR)
BIP1
PRESSURE
RETURN
RETAINED FLUID
SYSTEM CONDITION
GEAR SELECTED DOWN
GEAR DOWN & LOCKED
MAIN GEAR DOORS CLOSED
STEERING & LOCK CHANGE OVER VALVE
NOSE UPLOCK/DOWNLOCK JACK
C
XAB32/2315

Hydraulic Operation Diagram (1) -
(See also Figs. 7 to 11)
Figure 6


BIP1 No1 SYSTEM PRESSURE
BIR1 RETURN
LANDING GEAR CONTROL VALVE
TO SELECTOR LEVER
A CONNECTED TO FREE FALL SYSTEM
B TO AUTO-BRAKE JACK
C TO NOSEWHEEL STEERING
B
A
LOWER LINE
BIP2
BIP 3
RAISE LINE
DOOR CONTROL VALVE
SHUTTLE VALVE
DOOR CONTROL VALVE
DOOR UPLOCK JACK
BIP 35
BIP52
BIP 44
DOOR UPLOCK JACK
BIP 34
BIP 30
BIP 44
DOOR JACK
RELAY VALVE
DOOR JACK
A
A
BIP 32
BIP 45
BIP 33
BIP 24
BIP 2
BIP 25
DOOR SERVO VALVES
BIP 26
BIP 27
RELAY VALVE
BIP 16
BIP 24
BIP27
BIP 2
RELAY & LOCK VALVE
BIP 2
MAIN DOWNLOCK JACKS
BIP3
BIP3
A
BIP 20
BIP 21
MAIN GEAR RETRACTION JACKS
BIP19
BIP 18
BIP 2
BIP 3
SHUTTLE VALVE
NOSE RETRACTION JACK
BIP 2
BIP 37
BIP 2
CENTRING VALVE (STEERING GEAR)
BIP1
PRESSURE
RETURN
RETAINED FLUID
SYSTEM CONDITION
GEAR SELECTED UP
MAIN DOOR UPLOCKS RELEASED
MAIN DOORS OPENING
NOSE GEAR UP/ DOWN LOCK RELEASED
NOSE GEAR RETRACTING
STEERING & LOCK CHANGE OVER VALVE
NOSE UPLOCK/DOWNLOCK JACK
C
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Hydraulic Operation Diagram (2)

Figure 7

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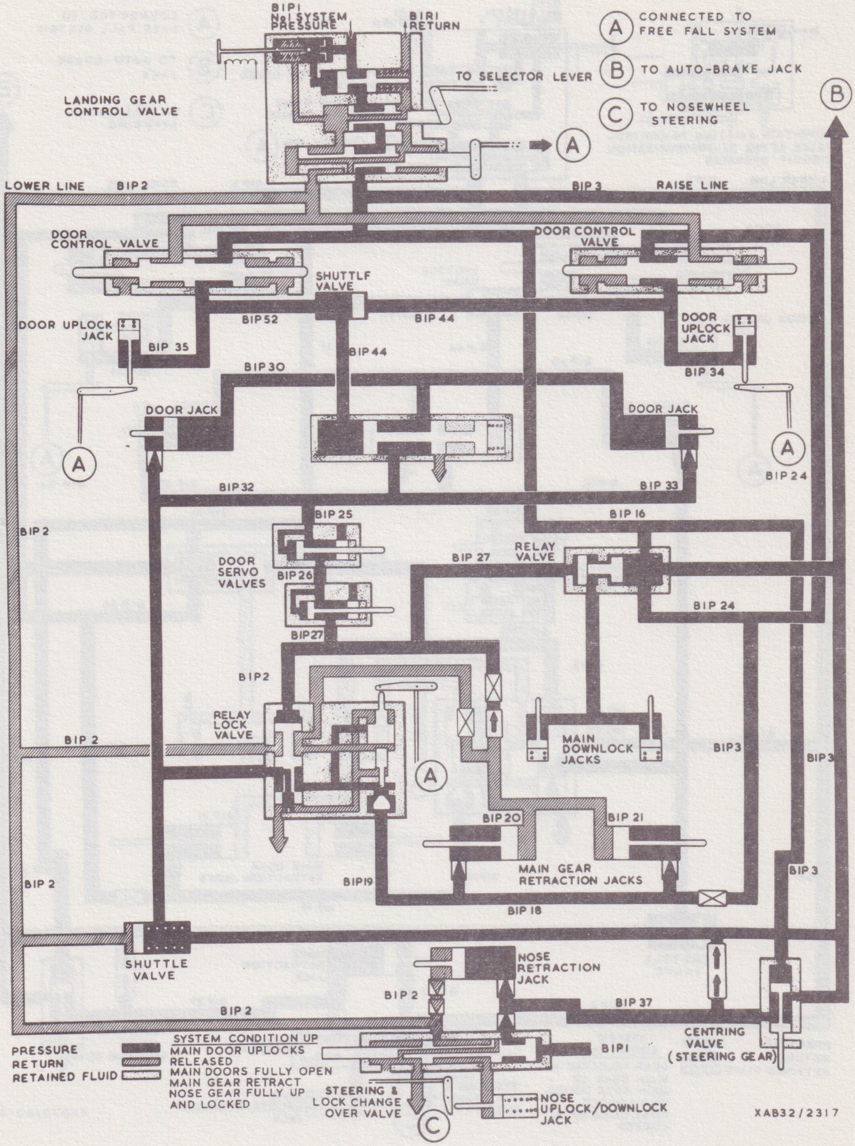
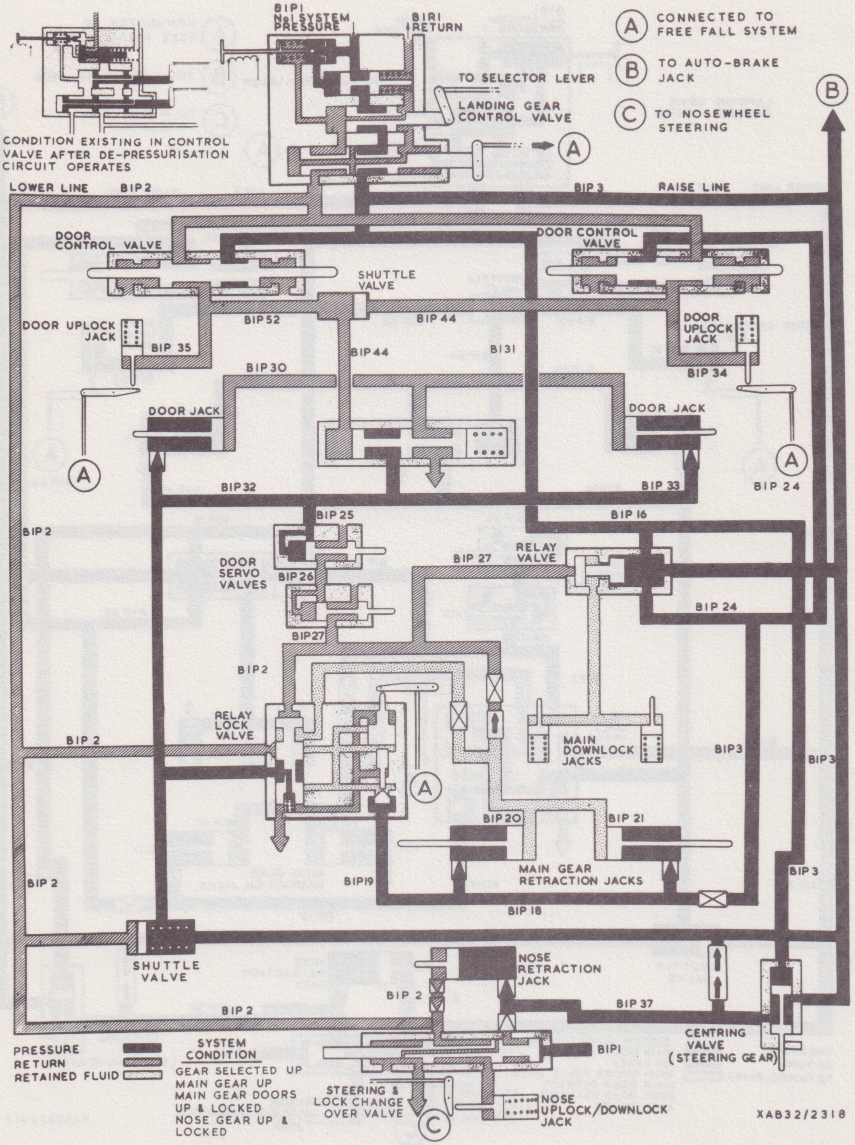

BIP1 No1 SYSTEM PRESSURE
BIR1 RETURN
LANDING GEAR CONTROL VALVE
TO SELECTOR LEVER
Ⓐ CONNECTED TO FREE FALL SYSTEM
Ⓑ TO AUTO-BRAKE JACK
Ⓒ TO NOSEWHEEL STEERING
Ⓐ
Ⓑ
LOWER LINE
BIP2
BIP3
RAISE LINE
DOOR CONTROL VALVE
DOOR CONTROL VALVE
SHUTTLF VALVE
BIP52
BIP44
DOOR UPLOCK JACK
BIP 35
DOOR UPLOCK JACK
BIP 34
BIP44
BIP30
DOOR JACK
DOOR JACK
Ⓐ
Ⓐ
BIP32
BIP 33
BIP24
BIP2
BIP25
BIP 16
DOOR SERVO VALVES
BIP26
BIP 27
RELAY VALVE
BIP 24
BIP27
BIP2
RELAY LOCK VALVE
BIP 2
Ⓐ
MAIN DOWNLOCK JACKS
BIP3
BIP3
BIP20
BIP 21
BIP19
MAIN GEAR RETRACTION JACKS
BIP 18
BIP3
BIP 2
SHUTTLE VALVE
NOSE RETRACTION JACK
BIP 2
BIP 37
BIP 2
CENTRING VALVE (STEERING GEAR)
BIP1
PRESSURE
RETURN
RETAINED FLUID
SYSTEM CONDITION UP
MAIN DOOR UPLOCKS RELEASED
MAIN DOORS FULLY OPEN
MAIN GEAR RETRACT
NOSE GEAR FULLY UP AND LOCKED
STEERING & LOCK CHANGE OVER VALVE
Ⓒ
NOSE UPLOCK/DOWNLOCK JACK
XAB32/2317

Hydraulic Operation Diagram (3)

Figure 8


BIP1
No1 SYSTEM
PRESSURE
BIR1
RETURN
TO SELECTOR LEVER
LANDING GEAR
CONTROL VALVE
A CONNECTED TO FREE FALL SYSTEM
B TO AUTO-BRAKE JACK
C TO NOSEWHEEL STEERING
CONDITION EXISTING IN CONTROL VALVE AFTER DE-PRESSURISATION CIRCUIT OPERATES
LOWER LINE
BIP2
BIP3
RAISE LINE
DOOR CONTROL VALVE
SHUTTLE VALVE
DOOR CONTROL VALVE
BIP52
BIP44
DOOR UPLOCK JACK
BIP 35
BIP44
BI31
DOOR UPLOCK JACK
BIP 34
BIP30
DOOR JACK
DOOR JACK
A
A
BIP32
BIP 33
BIP 24
BIP2
BIP25
BIP 16
DOOR SERVO VALVES
BIP26
BIP 27
RELAY VALVE
BIP27
BIP 24
BIP2
RELAY LOCK VALVE
BIP 2
A
MAIN DOWNLOCK JACKS
BIP3
BIP3
BIP20
BIP 21
BIP2
BIP19
MAIN GEAR RETRACTION JACKS
BIP 18
BIP3
SHUTTLE VALVE
NOSE RETRACTION JACK
BIP 2
BIP 37
BIP 2
BIP1
CENTRING VALVE (STEERING GEAR)
PRESSURE
RETURN
RETAINED FLUID
SYSTEM CONDITION
GEAR SELECTED UP
MAIN GEAR UP
MAIN GEAR DOORS UP & LOCKED
NOSE GEAR UP & LOCKED
STEERING & LOCK CHANGE OVER VALVE
C
NOSE UPLOCK/DOWNLOCK JACK
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Hydraulic Operation Diagram (4)
Figure 9

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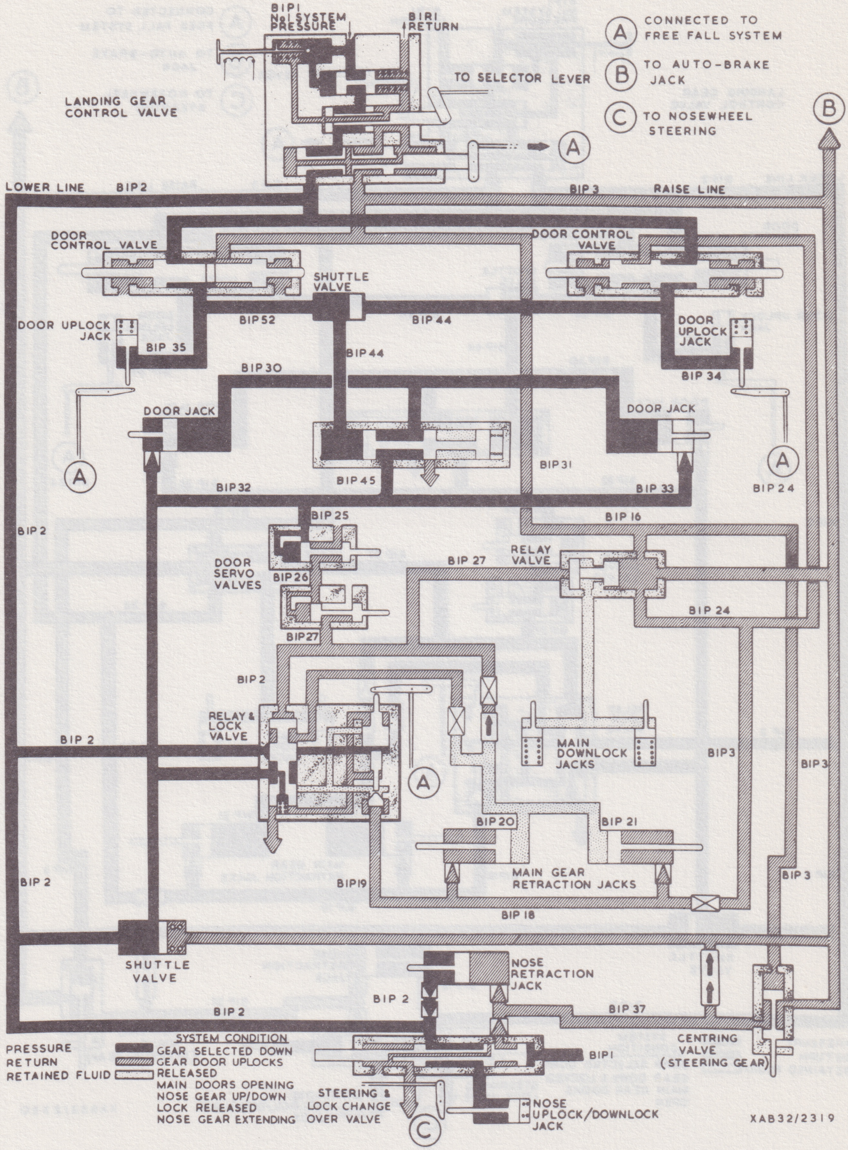
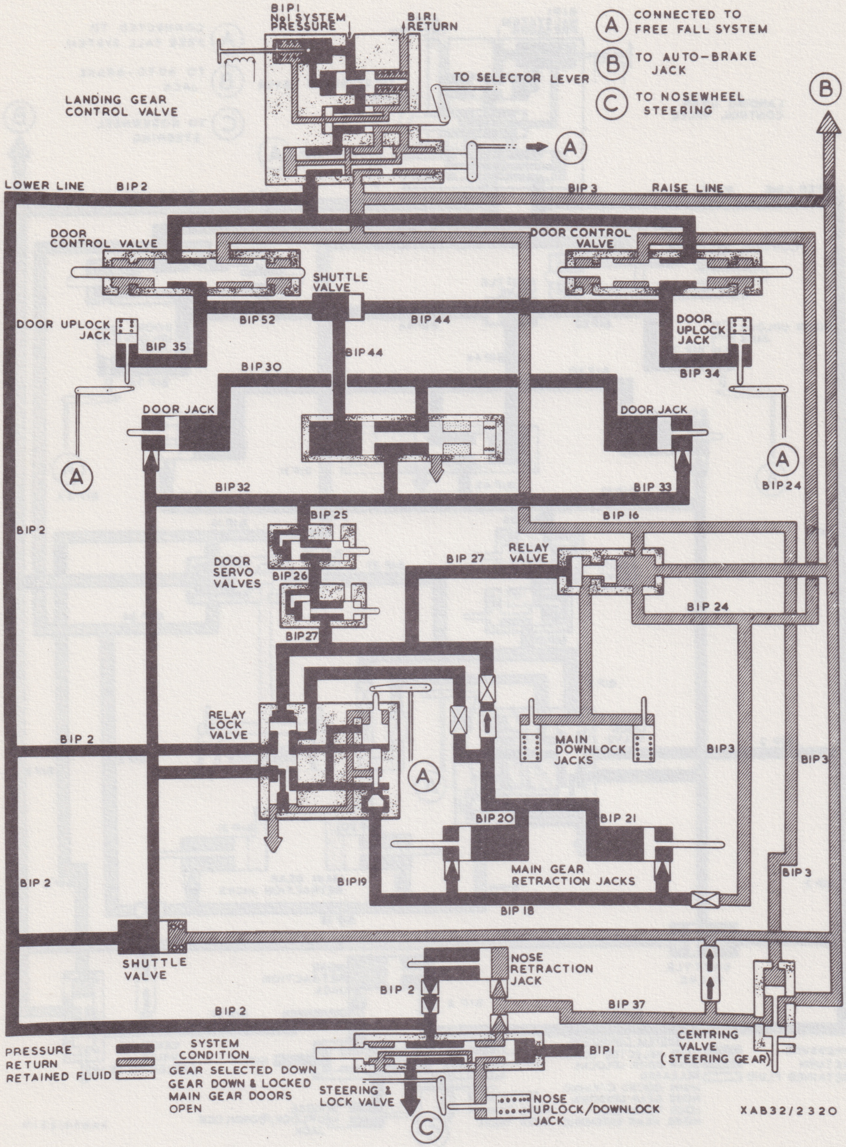

BIP1
No1 SYSTEM PRESSURE
BIR1
RETURN
LANDING GEAR CONTROL VALVE
TO SELECTOR LEVER
A CONNECTED TO FREE FALL SYSTEM
B TO AUTO-BRAKE JACK
C TO NOSEWHEEL STEERING
A
B
LOWER LINE
BIP2
BIP3
RAISE LINE
DOOR CONTROL VALVE
DOOR CONTROL VALVE
SHUTTLE VALVE
BIP52
BIP44
DOOR UPLOCK JACK
BIP 35
DOOR UPLOCK JACK
BIP 34
BIP44
BIP30
DOOR JACK
DOOR JACK
A
A
BIP31
BIP45
BIP32
BIP 33
BIP24
BIP2
BIP25
BIP16
DOOR SERVO VALVES
BIP26
BIP 27
RELAY VALVE
BIP 24
BIP27
BIP 2
RELAY & LOCK VALVE
BIP 2
MAIN DOWNLOCK JACKS
BIP3
BIP3
A
BIP20
BIP 21
BIP 2
BIP19
MAIN GEAR RETRACTION JACKS
BIP 3
BIP 18
SHUTTLE VALVE
NOSE RETRACTION JACK
BIP 2
BIP 37
BIP 2
CENTRING VALVE (STEERING GEAR)
BIP1
PRESSURE
RETURN
RETAINED FLUID
SYSTEM CONDITION
GEAR SELECTED DOWN
GEAR DOOR UPLOCKS RELEASED
MAIN DOORS OPENING
NOSE GEAR UP/DOWN LOCK RELEASED
NOSE GEAR EXTENDING
STEERING & LOCK CHANGE OVER VALVE
NOSE UPLOCK/DOWNLOCK JACK
C
XAB32/2319

Hydraulic Operation Diagram (5)

Figure 10


BIP1 No1 SYSTEM PRESSURE
BIR1 RETURN
Ⓐ CONNECTED TO FREE FALL SYSTEM
Ⓑ TO AUTO-BRAKE JACK
Ⓒ TO NOSEWHEEL STEERING
LANDING GEAR CONTROL VALVE
TO SELECTOR LEVER
A
B
LOWER LINE
BIP2
BIP3
RAISE LINE
DOOR CONTROL VALVE
DOOR CONTROL VALVE
SHUTTLE VALVE
BIP52
BIP44
DOOR UPLOCK JACK
BIP 35
BIP44
DOOR UPLOCK JACK
BIP 34
BIP30
DOOR JACK
DOOR JACK
A
A
BIP32
BIP 33
BIP24
BIP 2
BIP25
BIP 16
DOOR SERVO VALVES
BIP26
BIP27
BIP 27
RELAY VALVE
BIP 24
RELAY LOCK VALVE
BIP 2
MAIN DOWNLOCK JACKS
BIP3
BIP3
A
BIP20
BIP 21
BIP 2
BIP19
MAIN GEAR RETRACTION JACKS
BIP 18
BIP 3
SHUTTLE VALVE
NOSE RETRACTION JACK
BIP 2
BIP 2
BIP 37
CENTRING VALVE (STEERING GEAR)
BIP1
PRESSURE
RETURN
RETAINED FLUID
SYSTEM CONDITION
GEAR SELECTED DOWN
GEAR DOWN & LOCKED
MAIN GEAR DOORS OPEN
STEERING & LOCK VALVE
NOSE UPLOCK/DOWNLOCK JACK
C
XAB32/2320

Hydraulic Operation Diagram (6)

Figure 11

LANDING GEAR — SERVICING

LUBRICATION

This (periodic) item is particularly important and should never be allowed to overrun the recommended schedules.

Lubrication must be carried out strictly in accordance with the detailed charts contained in the aircraft Maintenance Manual.

TYRE PRESSURE

The recommended inflation pressure for the mainwheel tyres (40 x 12 - 18) is dependent on the take-off weight of the aircraft.

All tyres must be of the same type.

The pressure for the nosewheel tyres (24 x 7.25 - 12) remains constant for all weight conditions.

The pressure of both tyres on any one shock-absorber strut must be equal.

NOTE: The following table is included in order to satisfy critical runway load classification number (LCN) requirements. Where the LCN is not critical, the highest possible pressure for the appropriate weight is recommended. This will give longer tyre life.

TAKE-OFF WEIGHT	MAIN WHEELS P.S.I.		NOSE WHEELS P.S.I.	
LB.	LOADED	UNLOADED	LOADED	UNLOADED
55,000	94 +6 -0	90 +6 -0		
60,000	104 +10 -0	100 +10 -0		
65,000	114 +10 -0	110 +10 -0		
70,000	122 +10 -0	117 +10 -0		
75,000	130 +10 -0	125 +10 -0	120 +10 -0 for all weights up to 104,500 lb.	115 +10 -0
80,000	139 +10 -0	134 +10 -0		
85,000	148 +10 -0	142 +10 -0		
91,000	158 +10 -0	152 +10 -0		
93,000	161 +10 -0	155 +10 -0		
98,000	168 +10 -0	161 +10 -0		
100,000	171 +10 -0	164 +10 -0		
104,000	177 +10 -0	170 +10 -0		

Tyre Pressures
Table 101

CAUTION: THE UNLOADED CONDITION IS WHEN THE WEIGHT OF THE AIRCRAFT IS OFF THE WHEELS, E.G. WITH THE AIRCRAFT ON JACKS OR BEFORE A WHEEL IS FITTED.

TYRE CREEP

Regularly check for tyre creep. It is most likely to occur during bedding-in over the first five landings after fitting, whence it should virtually cease.

Pressure loss may result if creep continues.

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WHEEL-CHANGING

NOTES: The aircraft should be jacked by reference to Section 1-1-0.

Ensure that tyre pressures are correct (see Table 101) before de-jacking aircraft.

Either Dunlop or Bendix wheels can be fitted. Wheels without and with brake cooling fans are not interchangeable due to differences in the transducer drive; Figs. 101 and 101A apply respectively.

Dunlop mainwheels, without brake fans, differ from Bendix in that the seal retainer (Fig.101, Item 6) is separately attached to the hub and not disturbed when removing the drive cover (7). Procedures are in all other respects identical.

MAIN WHEELS (WITHOUT BRAKE COOLING FANS) - (Fig.101)

1. If brake units are not be be removed, apply the parking brake to keep the brake segmented rotors and rotor drive keys aligned, otherwise an alignment fixture (Part No.A11553) may be required when fitting replacement wheel.
2. Remove all attaching items (4 to 10 - Bendix) - (4 to 5, 7 to 10 - Dunlop) and use a thread protector and lead-in tool (Part No.AB94A447) when removing the wheel.
3. Before fitting replacement wheel, ascertain that its roller bearings have been correctly packed with the correct grade of high-temperature, water-resistant grease (Specification DTD 878 or MIL-L-3545) e.g. Aeroshell No.5.
4. Ensure correct adjustment of wheel bearings by torque-tightening the axle nut (10) using an adapter (Part No.AB94-2307) as follows:-
   (a) Tighten the nut, whilst rotating wheel, to 240 lb.ft.
   (b) Slacken the nut, then tighten to 80 lb.ft.
   (c) Further tighten nut, if necessary, to next locking position.
5. When torque spanners are unavailable, adjust the bearings by the following alternative method:
   (a) Hand-tighten the axle nut whilst rotating wheel, then use a suitable C-spanner or hammer-and-drift to tighten a further half-turn.
   (b) Slacken nut, then retighten until only slight play can be felt at the tyre periphery.
   (c) Tighten nut a further quarter-turn then, if necessary, slacken to nearest locking position.
6. Use a new split pin to secure the nut and washer on to the axle nut lockbolt (9).
7. When fitting the seal retainer and transducer drive cover (7), torque-tighten bolts (8) to 40 lb. in.

MAIN WHEELS (WITH BRAKE COOLING FANS) - (Fig.101A)

The procedure and torque values used when changing this type are identical to those described above, with the exception of the impeller and transducer drive assembly, described below.

1. Before removing wheel detach items 12 to 16.
2. After fitting wheel, mate impeller (12) with fan motor shaft (5); fit spring washer (13) and securely tighten hollow bolt (14). Carefully slide debris guard (15) on to transducer drive shaft (6) and secure with fasteners (16).

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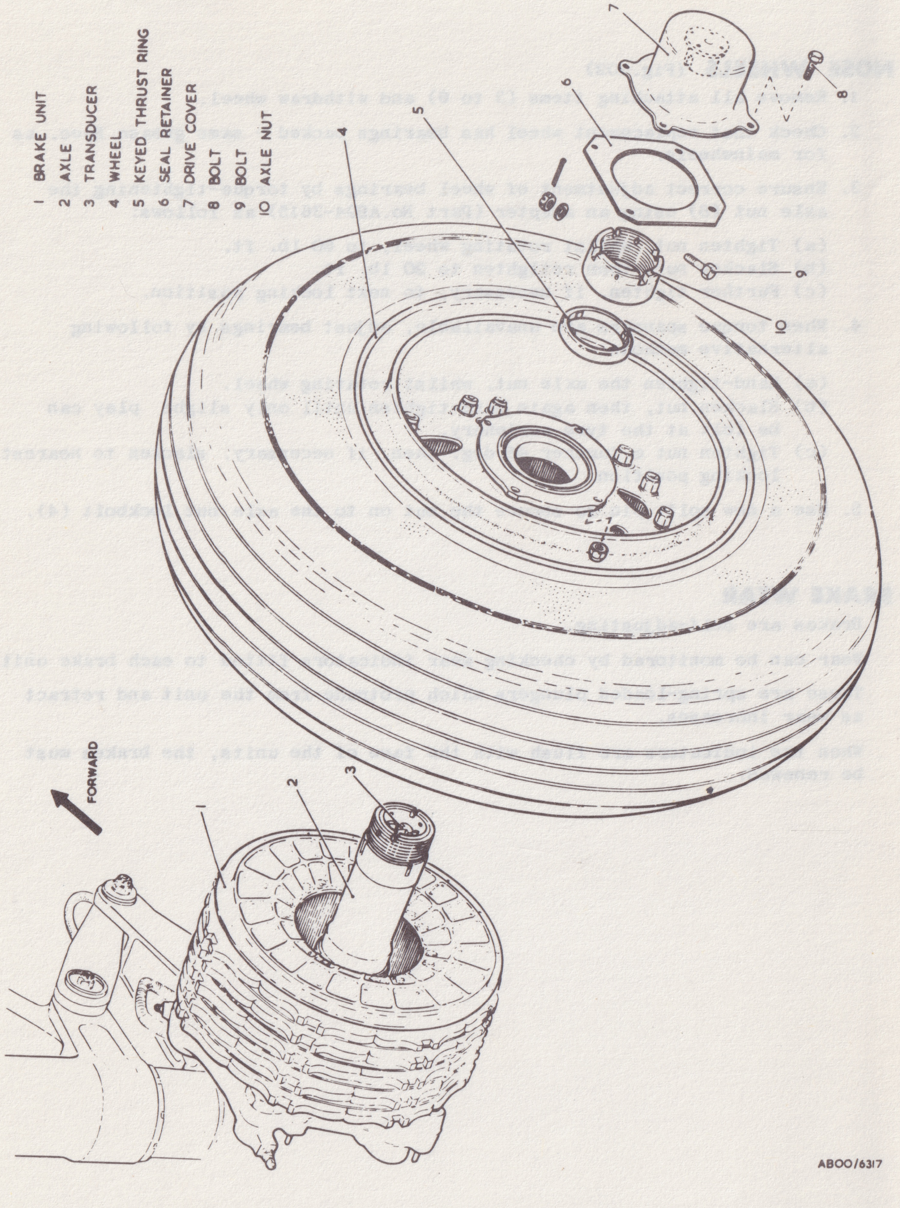
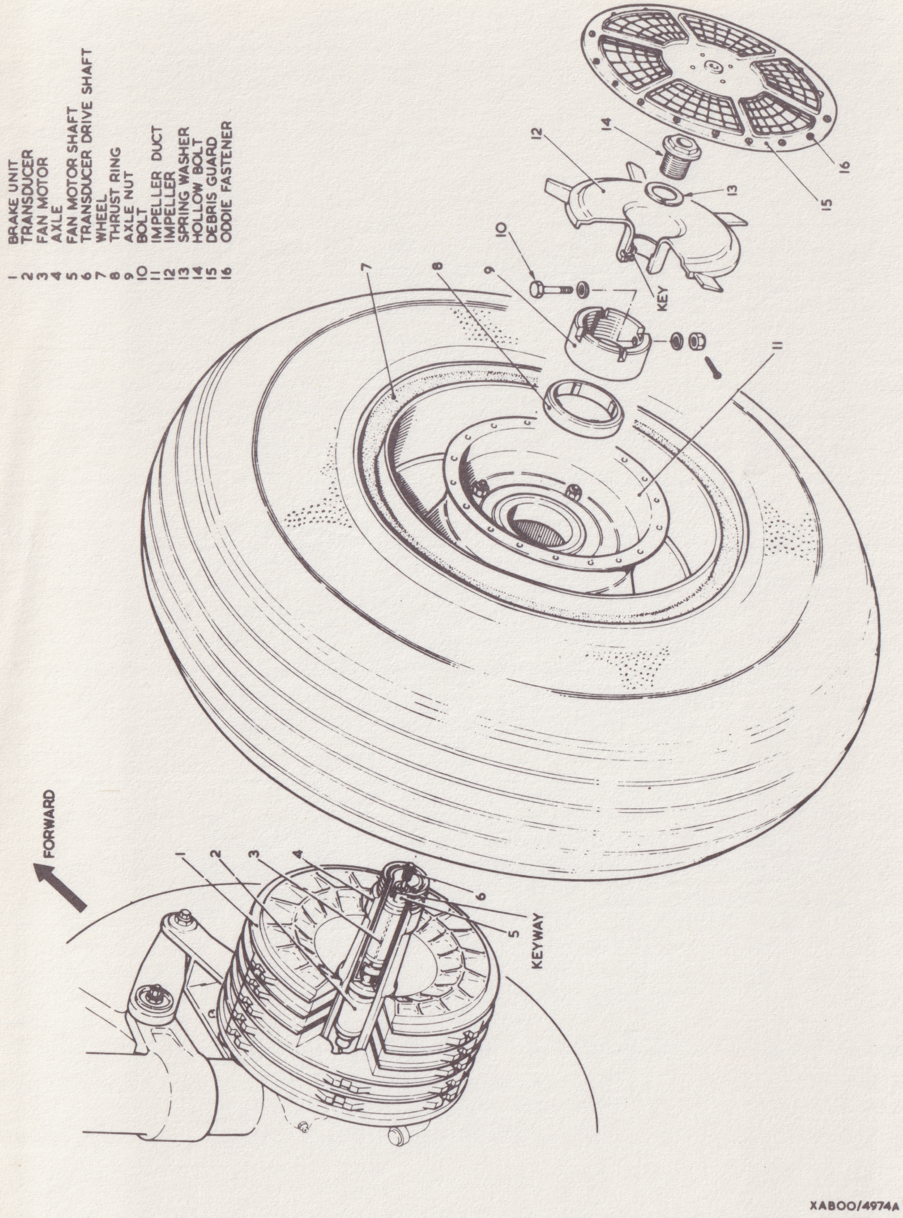

1 BRAKE UNIT
2 AXLE
3 TRANSDUCER
4 WHEEL
5 KEYED THRUST RING
6 SEAL RETAINER
7 DRIVE COVER
8 BOLT
9 BOLT
10 AXLE NUT
FORWARD
1
2
3
4
5
6
7
8
9
10
ABOO/6317

Mainwheels - Removal/Installation
(For wheels with Brake Cooling Fans, refer to Fig.101A)
Figure 101


1 BRAKE UNIT
2 TRANSDUCER
3 FAN MOTOR
4 AXLE
5 FAN MOTOR SHAFT
6 TRANSDUCER DRIVE SHAFT
7 WHEEL
8 THRUST RING
9 AXLE NUT
10 BOLT
11 IMPELLER DUCT
12 IMPELLER
13 SPRING WASHER
14 HOLLOW BOLT
15 DEBRIS GUARD
16 ODDIE FASTENER
KEY
KEYWAY
FORWARD
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
XABOO/4974A

Mainwheels (with Brake Cooling Fan) - Removal/Installation
Figure 101A

NOSE WHEELS (Fig. 102)

1. Remove all attaching items (3 to 6) and withdraw wheel.
2. Check that replacement wheel has bearings packed - same grease Spec. as for mainwheels.
3. Ensure correct adjustment of wheel bearings by torque-tightening the axle nut (6) using an adapter (Part No.AB94-3615) as follows:
   - (a) Tighten nut, whilst rotating wheel, to 60 lb. ft.
   - (b) Slacken nut, then retighten to 20 lb. ft.
   - (c) Further tighten, if necessary, to next locking position.
4. When torque spanners are unavailable, adjust bearings by following alternative method:
   - (a) Hand-tighten the axle nut, whilst rotating wheel.
   - (b) Slacken nut, then again hand-tighten until only slight play can be felt at the tyre periphery.
   - (c) Tighten nut a further 45 deg. then, if necessary, slacken to nearest locking position.
5. Use a new split pin to secure the nut on to the axle nut lockbolt (4).

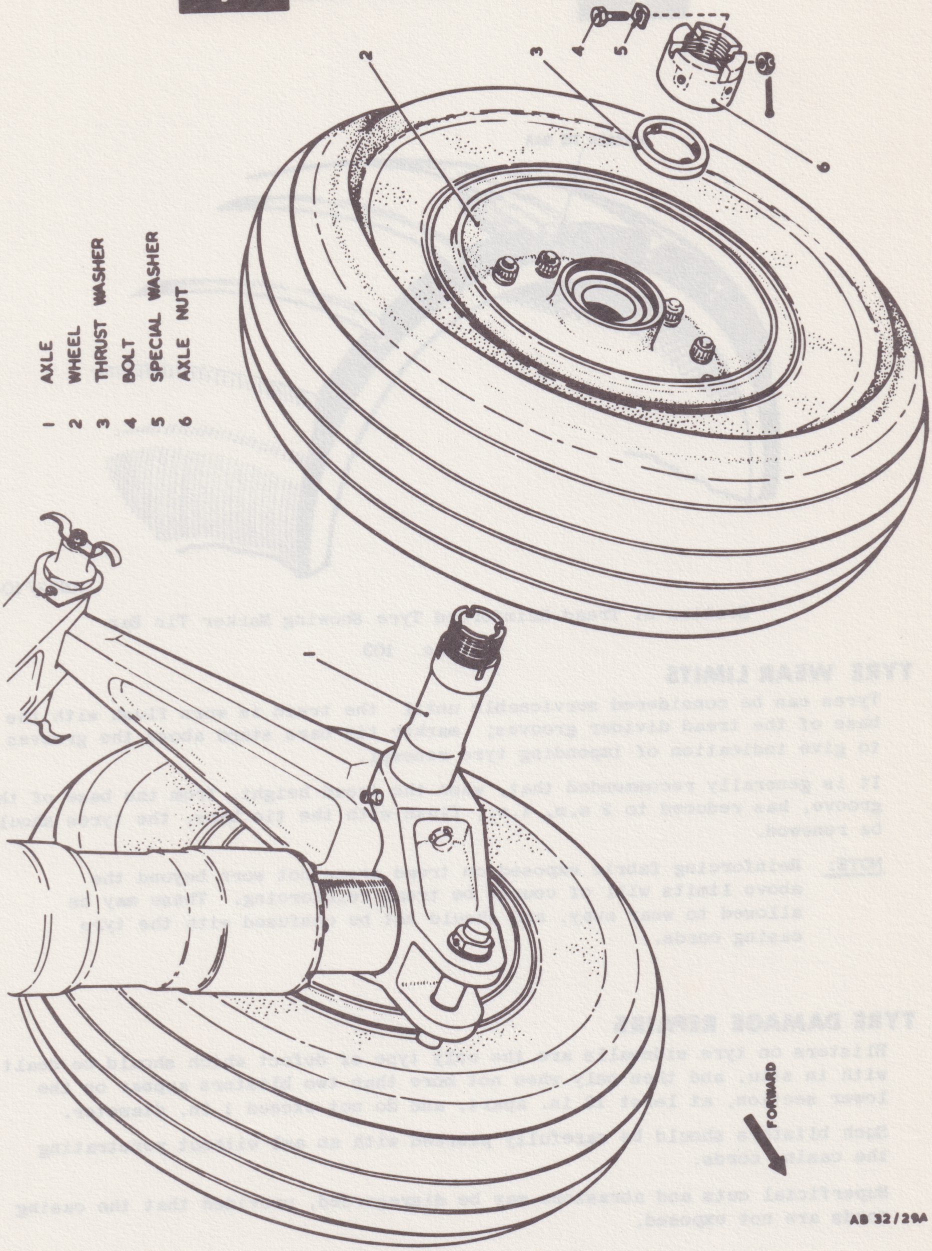
BRAKE WEAR

Brakes are self-adjusting.

Wear can be monitored by checking wear indicators fitted to each brake unit.

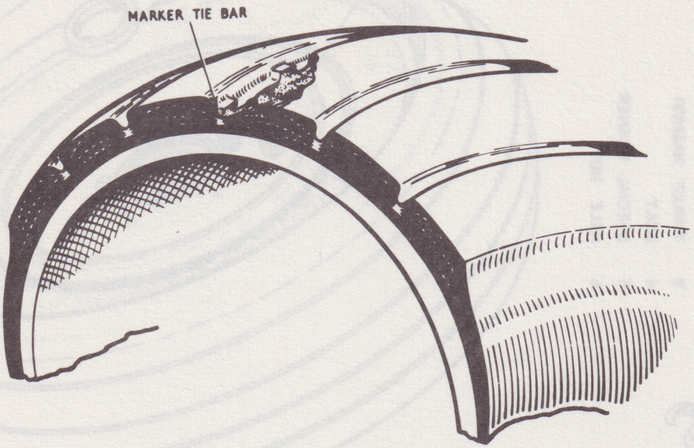
These are spring-loaded plungers which protrude from the unit and retract as wear increases.

When the indicators are flush with the face of the units, the brakes must be renewed.


1 AXLE
2 WHEEL
3 THRUST WASHER
4 BOLT
5 SPECIAL WASHER
6 AXLE NUT
1
2
3
4
5
6
FORWARD
AB 32/29A

B0682

Nose Wheels - Removal/Installation
Figure 102



Section of Tread Reinforced Tyre Showing Marker Tie Bar

Figure 103

TYRE WEAR LIMITS

Tyres can be considered serviceable until the tread is worn flush with the base of the tread divider grooves; marker tie bars stand above the grooves to give indication of impending tyre renewal.

It is generally recommended that, when the tread height, from the base of the groove, has reduced to 2 m.m. i.e., flush with the tie bars, the tyres should be renewed.

NOTE: Reinforcing fabric exposed on tread areas not worn beyond the above limits will of course be tread reinforcing. These may be allowed to wear away, and should not be confused with the tyre casing cords.

TYRE DAMAGE REPAIRS

Blisters on tyre sidewalls are the only type of defect which should be dealt with in situ, and then only when not more than two blisters appear on the lower section, at least 12 in. apart, and do not exceed 1 in. diameter.

Such blisters should be carefully pierced with an awl without penetrating the casing cords.

Superficial cuts and abrasions may be disregarded, provided that the casing cords are not exposed.

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B068211

MAIN SHOCK-ABSORBER STRUTS

WARNING: DANGER - THE STRUTS MUST BE FULLY COMPRESSED WITH ALL AIR PRESSURE RELEASED BEFORE CHARGING.

DO NOT JACK THE AIRCRAFT.

TAKE EVERY PRECAUTION WHILE CHARGING TO PREVENT GRIT ETC. ENTERING THE STRUTS.

Fluid Charging - Standard Method

1. Slowly unscrew fluid charging valve 'B' two complete turns and release all pressure from the strut.
2. Connect a hydraulic (DTD 585 or MIL 5606) supply line to valve 'B' and pump in fluid until a pressure of 200 p.s.i. is reached.
3. Tighten valve 'B' and disconnect the hydraulic supply line.
4. Connect a flexible tube to valve 'B' and route this to a suitable fluid container.
5. Slowly slacken valve 'B' and allow excess fluid to be expelled.
6. Connect a clean, dry air supply to air charging valve 'C' and air-charge slowly until fluid ceases to flow from valve 'B'.
7. Tighten valve 'B' and air-charge the strut as detailed under 'Air Charging'.

Fluid Charging - Alternative Method

CAUTION: THIS METHOD DISTURBS THE AIR CHARGING VALVE SEAL, THEREFORE THE VALVE SHOULD BE CHECKED FOR LEAKAGE ON COMPLETION.

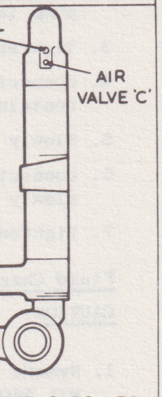
1. Remove air charging valve 'C' and fill the strut with fluid (DTD 585 or MIL 5606) until the fluid reaches the level of the air charging valve hole.
2. Clean and refit valve 'C'.
3. Unscrew valve 'B' two complete turns.
4. Connect a clean, dry air supply to valve 'C' and air-charge slowly until fluid ceases to flow from valve 'B'.
5. Tighten valve 'B' and air-charge the strut as detailed under 'Air Charging'.

PRINTED IN

NOTE
THE AIR CHARGING GRAPH IS BASED ON THIS TABLE. THE TABLE IS DISPLAYED ON THE UNDERCARRIAGE SIDESTAY

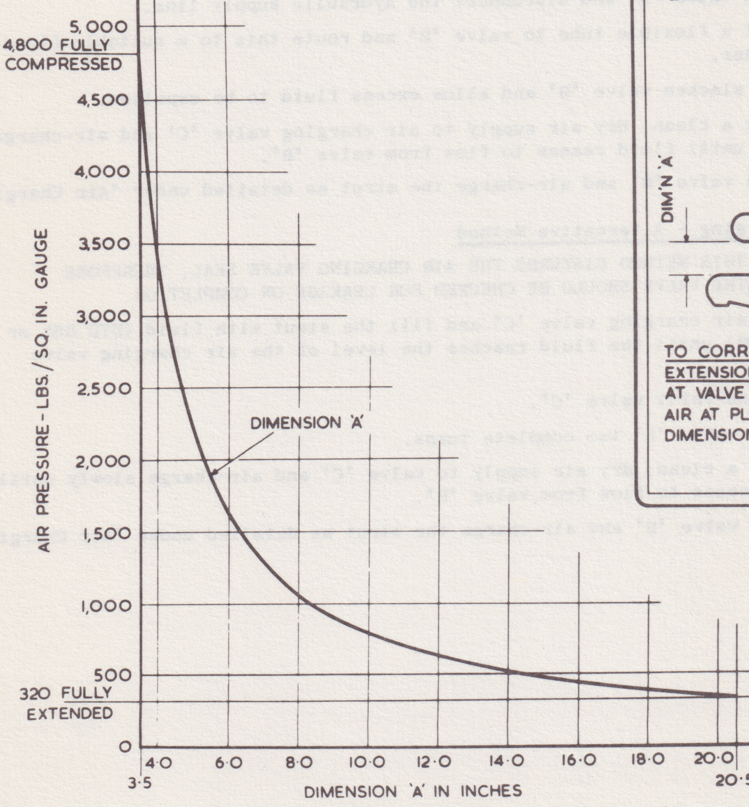
MAIN OLEO EXTENSION CHART

A/C WT. LBS	PRESSURE P.S.I.	DIM'N 'A' IN.
55,000	1,320	6·85
60,000	1,435	6·50
65,000	1,560	6·15
70,000	1,675	5·85
75,000	1,800	5·60
80,000	1,915	5·40
85,000	2,020	5·25
90,000	2,130	5·10
95,000	2,210	5·00
97,500	2,250	4·95



TO CORRECT OLEO LEG EXTENSION - CHARGE AIR AT VALVE 'C', OR RELEASE AIR AT PLUG 'B' TO OBTAIN DIMENSION 'A'

EZ43 221



AB32/2052

Main Shock-absorber Strut Charging

Figure 104

Air Charging

1. Ensure that the strut is correctly charged with fluid as detailed under 'Fluid Charging'
2. Connect a clean, dry air supply and gauge to air charging valve 'C' and air-charge the strut until dimension 'A' is approximately 7.0 in.
3. Carry out operations detailed under 'Check or adjust Strut Air Pressure'.

Check or Adjust Strut Air Pressure

1. Connect a clean, dry air supply and gauge to air charging valve 'C'.
2. Measure dimension 'A' on the strut and, from the graph, ascertain what the pressure should be in the strut.
3. Slowly increase pressure in the air line until it is approximately 25 p.s.i. above that indicated on the graph in Operation 2, then shut off the air supply at source.
4. Open valve 'C' by means of the gauge and allow air pressure in strut, air line and gauge to stabilize.
5. Measure dimension 'A' on the strut. If it does not coincide with that indicated on the graph, adjust the pressure either by admitting air through valve 'C' or by releasing air through valve 'B' until the dimensions 'A' agree.
6. Wire-lock valve 'B' and fit blanking caps to it and to valve 'C'.
7. Refit the grease nipple removed from the strut gland before the strut was depressurized (if applicable).

Main Shock-absorber Struts
(concluded)

NOSE SHOCK - ABSORBER STRUT

WARNING: DANGER - THE STRUT MUST BE FULLY COMPRESSED WITH ALL AIR PRESSURE RELEASED BEFORE CHARGING.

DO NOT JACK THE AIRCRAFT.

TAKE EVERY PRECAUTION WHILE CHARGING TO PREVENT GRIT ETC. ENTERING THE STRUT.

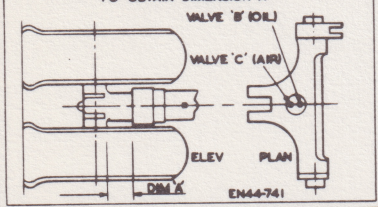
Fluid Charging - Standard Method

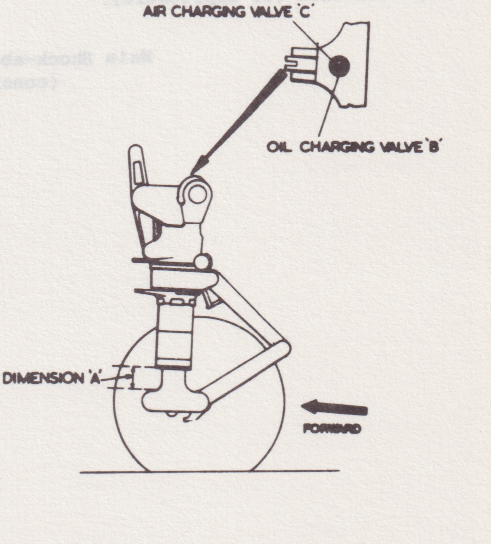
1. Slowly unscrew fluid charging valve 'B' two complete turns and release all pressure from the strut.
2. Connect a hydraulic (DTD 585 or MIL 5606) supply line to valve 'B' and pump in fluid until a pressure of 200 p.s.i. is reached.
3. Tighten valve 'B' and disconnect the hydraulic supply line.
4. Connect a flexible tube to valve 'B' and route this to a suitable fluid container.
5. Slowly slacken valve 'B' and allow excess fluid to be expelled.
6. Connect a clean, dry air supply to air charging valve 'C' and air-charge slowly until fluid ceases to flow from valve 'B'.
7. Tighten valve 'B' and air-charge the strut as detailed under 'Air Charging'.

NOSE OLEO LEG EXTENSION CHART

A/C WT	C.G. FORWARD		C.G. MID		C.G. AFT	
LB	DIM 'A'	PRESS	DIM 'A'	PRESS	DIM 'A'	PRESS
65000	3·45	750	4·8	540	8·3	330
70000	3·2	805	4·5	580	7·5	360
75000	2·9	865	4·2	620	7·0	385
80000	2·7	925	3·9	665	6·5	410
84000	2·6	950	3·7	690	6 2	430
88000	2·55	965	3·55	725	5·3	500
91000	2·5	975	3·45	750	4·7	550
96000	2·45	985	3·0	830	3·8	685
100,000	2·35	992	2·85	860	3·25	787

TO CORRECT OLEO LEG EXTENTION
CHARGE AIR AT VALVE 'C' OR RELEASE AIR AT VALVE 'B'
TO OBTAIN DIMENSION 'A'





XAB32/1712A

Nose Shock-absorber Strut Charging-
(See also Figure 106)
Figure 105

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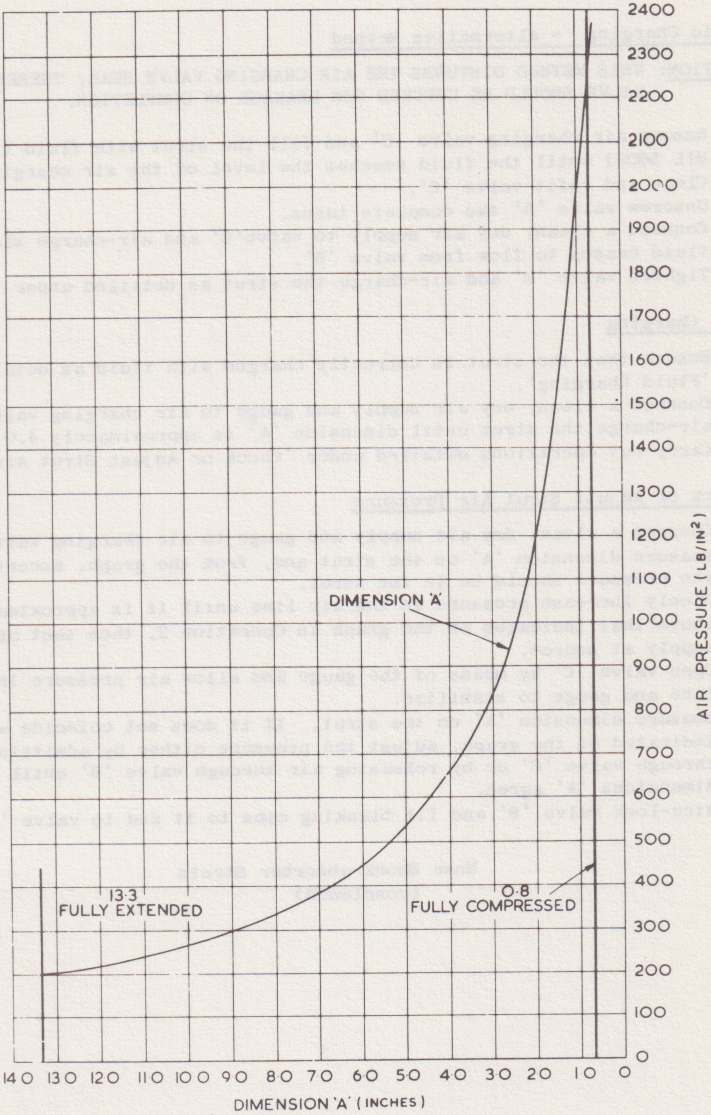


XAB 32/1397

Nose Shock-absorber Strut Charging -
(See also Figure 105)
Figure 106

Fluid Charging - Alternative Method

CAUTION: THIS METHOD DISTURBS THE AIR CHARGING VALVE SEAL, THEREFORE THE VALVE SHOULD BE CHECKED FOR LEAKAGE ON COMPLETION.

1. Remove air charging valve 'C' and fill the strut with fluid (DTD 585 or MIL 5606) until the fluid reaches the level of the air charging valve hole.
2. Clean and refit valve 'C'.
3. Unscrew valve 'B' two complete turns.
4. Connect a clean, dry air supply to valve'C' and air-charge slowly until fluid ceases to flow from valve 'B'.
5. Tighten valve 'B' and air-charge the strut as detailed under 'Air Charging'.

Air Charging

1. Ensure that the strut is correctly charged with fluid as detailed under 'Fluid Charging'.
2. Connect a clean, dry air supply and gauge to air charging valve 'C' and air-charge the strut until dimension 'A' is approximately 4.0 in.
3. Carry out operations detailed under 'Check or Adjust Strut Air Pressure'.

Check or Adjust Strut Air Pressure

1. Connect a clean, dry air supply and gauge to air charging valve 'C'.
2. Measure dimension 'A' on the strut and, from the graph, ascertain what the pressure should be in the strut.
3. Slowly increase pressure in the air line until it is approximately 25 p.s.i. above that indicated on the graph in Operation 2, then shut off the air supply at source.
4. Open valve 'C' by means of the gauge and allow air pressure in strut, air line and gauge to stabilize.
5. Measure dimension 'A' on the strut. If it does not coincide with that indicated on the graph, adjust the pressure either by admitting air through valve 'C' or by releasing air through valve 'B' until the dimensions 'A' agree.
6. Wire-lock valve 'B' and fit blanking caps to it and to valve 'C'.

Nose Shock-absorber Struts
(concluded)

LIGHTS

General

The aircraft is fitted with fluorescent tube lighting supplied from the 200/115-volt a.c. system, and filament lamp lighting supplied from the 28-volt d.c. normal or 6-volt emergency systems.

FLIGHT DECK

General white lighting of the flight deck is provided by a roof lamp assembly incorporating red and white floodlamps. Transilluminated lighting of engravings is integral on panel E. The instruments on panel A are individually illuminated, and the panel is illuminated by red or white floodlamps mounted beneath the glareshield. The centre pedestal is floodlit by red or white lights mounted in the roof lamp assembly. Chart reading lamps are fitted in the roof above each pilot, and the map tables are illuminated by lamps recessed in each sidewall. Certain instruments such as the captain's ASI, are provided with individual floodlighting.

CABIN

The passenger cabin and vestibules are illuminated by lamp assemblies recessed along the roof centre-line at regular intervals. Each assembly contains both fluorescent tubes and filament lamps to provide bright or dim lighting respectively, and an additional emergency lamp. The passenger entrances are lit by white filament lamps and the service entrance by a roof lamp assembly. General lighting of the passenger cabin is controlled from the forward stewards' panel. Toilet lighting is provided by fluorescent tubes fitted behind translucent panels. Each passenger seat is served by an individual reading lamp. The lamps and control switches are fitted on the passenger service panels together with an attendant-call switch.

EXTERIOR

Illumination ahead of the aircraft when landing or taxiing is provided by three retractable lamps, one mounted in each wing leading edge, and one in the fuselage nose. A turn-off lamp mounted in each wing root fairing gives illumination to the left and right when the aircraft is taxiing. A navigation lamp is fitted at each wing tip and at the rear of the tailplane bullet. Anti-collision warning is given by two rotating beacons, mounted one on the top and one on the underside of the centre fuselage. Two ice inspection lamps in the forward fuselage and two in the wing trailing edges illuminate the wing leading edges and engine intakes respectively.

CARGO AND SERVICE BAYS

The forward and aft freight holds are illuminated by flush-mounted roof lamps, controlled by switches mounted immediately inside each freight hold door aperture. The undercarriage bays and the electrical equipment bay are provided with individual servicing lamps, controlled by a common switch on panel E.

EMERGENCY LIGHTS

Two emergency lighting systems provide lighting for essential internal areas. Both systems can be controlled manually by a pilot's or a cabin attendant's switch and light automatically if the d.c. main bus-bar supply fails. No.1 system is automatically switched on whenever the FASTEN SEAT BELTS or NO SMOKING signs are switched on.

No.1 system is supplied from the d.c. essential bus-bar. No.2 system comprises individual lamp assemblies powered from independent batteries and those lamp assemblies situated over exits may be removed and used as hand torches. Wiring provision is made for fixed external emergency lamps and their associated battery power packs.

NAVIGATION

PITOT AND STATIC

Pitot and static systems provide air pressures for the operation of various navigational instruments; also supplied are units of the auto-pilot, flight recorder, mach trim system and the high speed warning system.

Three externally mounted pitot heads transmit ram air pressure, which varies with aircraft speed, to the pitot system. Barometric pressure, which varies with aircraft altitude, is transmitted to the static system by five externally mounted static vents. Water drain valves are fitted at low points in the pipe runs where moisture may accumulate.

AIR DATA INSTRUMENTATION

The captain's and co-pilot's dashboard panels are fitted with an airspeed indicator which also displays the mach number, a vertical speed indicator and an altimeter. The two panels are supplied from separate pitot and static sources, selector valves enable each pilot to select an alternative static supply to his instruments. An auto-pilot isolating switch, which is fitted in the free-fall lever compartment, enables the auto-pilot air data sensor to be isolated from the pitot supply.

An outside air temperature indicator is fitted on the instrument panel, a standby altimeter may also be fitted. Dual high speed warning systems provide audible warning whenever the aircraft exceeds the maximum operating speed limit.

STALL PROTECTION

The stall warning system, comprising three sub-systems, will function automatically if aircraft performance approaches a stall condition. The sub-systems operate sequentially at pre-determined angles of incidence, detected by angle of airflow sensors mounted on the exterior of the fuselage.

Time delay relays prevent spurious operation of the system, caused by rapid rotation of the aircraft during take-off. Refer to 2-8-0 for details of system operation.

ATTITUDE AND DIRECTION INSTRUMENTATION

Mounted on each pilot's control panel is a flight director indicator, a course indicator, a compass indicator and a turn and slip indicator. Each instrument incorporates a malfunction warning flag.

The instruments provide steering commands, and display attitude and direction of flight information provided by steering computers, gyros and radio navigation equipment.

RADIO NAVIGATION

The radio navigation system uses both medium (MF) and very high (VHF) frequencies to provide direction finding facilities.

ADF (automatic direction finding) equipment provides automatic bearing information in relation to MF radio beacons. The information is presented visually on radio magnetic indicators, and aurally by means of the audio integrating systems.

VOR/ILS equipment provides information of aircraft deviation in relation to a desired course. The information is fed to the flight director indicators and to the auto-pilot, enabling automatic capture and subsequent flight along the radio beams.

Information on the distance of the aircraft from a fixed radio beacon is provided by the DME (distance measuring equipment) installation which operates in conjunction with the VOR/ILS system.

A VHF marker beacon receiver indicates, by means of three coloured lights on each pilot's control panel and by audio identification tones, when the aircraft is passing over airway or ILS marker beacons.

ATC TRANSPONDER

The ATC (air traffic control) transponder system enables both positive identification and accurate tracking of the aircraft by air traffic control, particularly during conditions of heavy ground clutter or inclement weather.

WEATHER RADAR

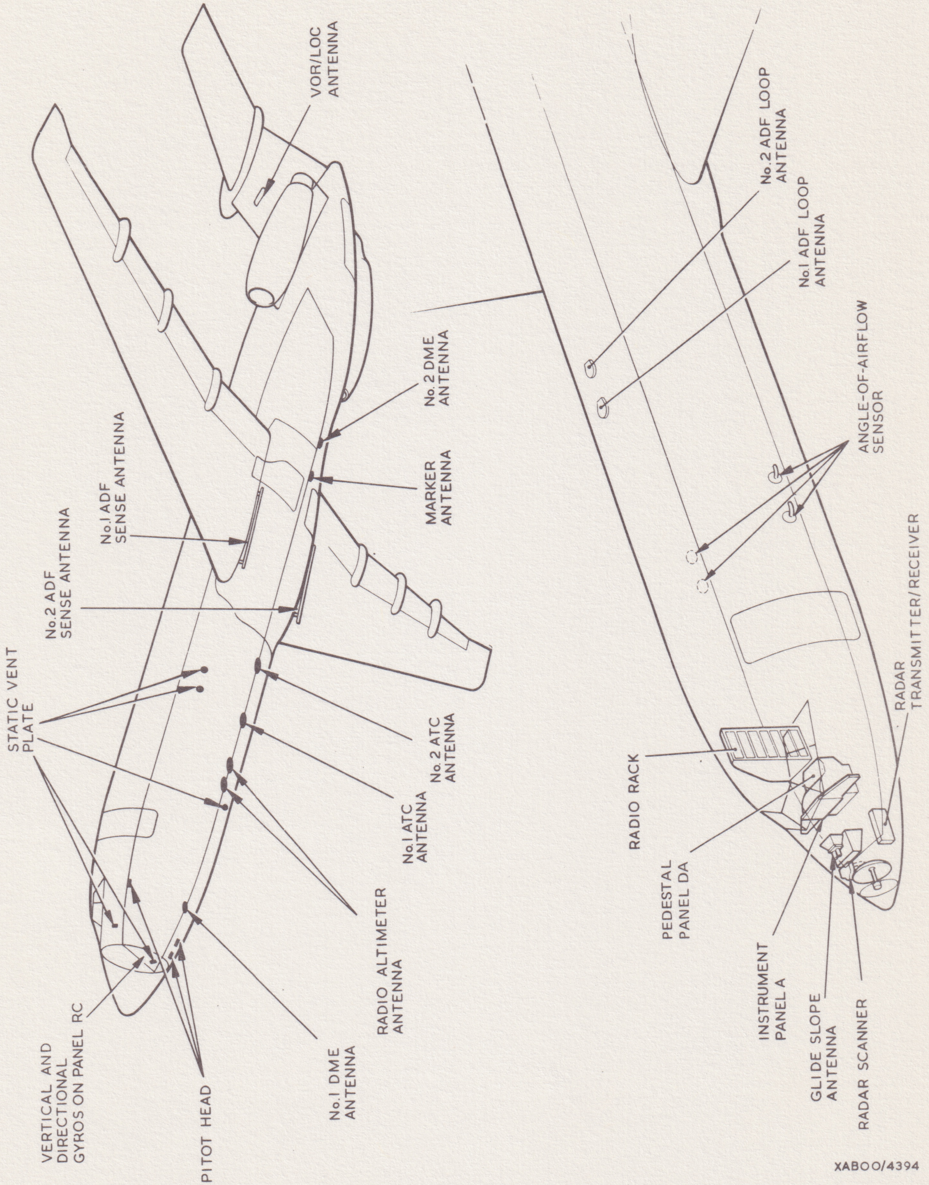
The weather radar installation detects the range and bearing of both normal cloud formations and turbulent cloud cores. Facilities are also included for mapping the terrain ahead of the aircraft. The information is pictorially displayed on cathode-ray tubes housed at the forward end of the left and right consoles. The radar scanner is mounted on the forward pressure bulkhead and enclosed by the radome, which forms the aircraft nose.

GROUND PROXIMITY WARNING

The ground proximity warning system is installed in some aircraft and generates warnings only; all corrective action must be manually initiated. The system provides visible and audible warnings of potentially dangerous flight near to, or toward, terrain and of excessive descent below the glide slope centre line during an ILS approach.
Excessive sink or ground closure rates, descent after take-off, proximity to the ground without landing gear etc. extended, or descent below glide slope centre line during ILS approach, will 'trigger' the warning system.

The 'pull-up' warning can be cancelled only by flying the aircraft out of danger.

Integral test circuits enable confidence testing to be initiated on the flight deck.


VOR/LOC ANTENNA
No.2 ADF LOOP ANTENNA
No.1 ADF LOOP ANTENNA
No.2 DME ANTENNA
MARKER ANTENNA
No.1 ADF SENSE ANTENNA
No.2 ADF SENSE ANTENNA
ANGLE-OF-AIRFLOW SENSOR
STATIC VENT PLATE
No.2 ATC ANTENNA
No.1 ATC ANTENNA
RADAR TRANSMITTER/RECEIVER
RADIO RACK
PEDESTAL PANEL DA
RADIO ALTIMETER ANTENNA
VERTICAL AND DIRECTIONAL GYROS ON PANEL RC
PITOT HEAD
No.1 DME ANTENNA
INSTRUMENT PANEL A
GLIDE SLOPE ANTENNA
RADAR SCANNER
XAB00/4394

Typical G.A. of Navigation System
Figure 1

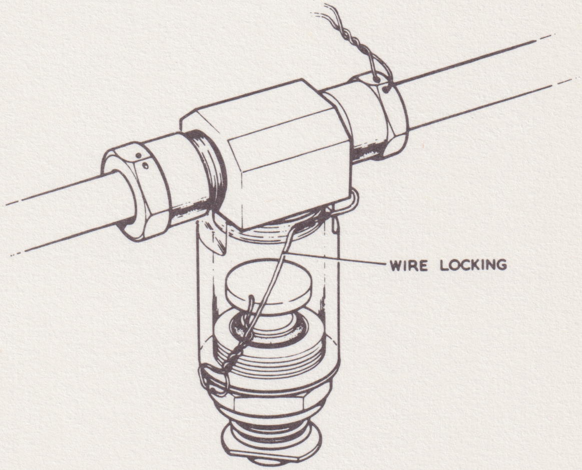
NAVIGATION - SERVICING

The pitot and static systems are fitted with a number of water drain valves which must be inspected regularly. The valves are normally located in the pipe-runs situated in the forward electrics bay.

Aircraft having flight recorder equipment fitted to the rear shear deck incorporate six additional valves; two in the electronics bay, two in the underfloor area of the forward freight hold and two in the extreme rear fuselage.

CAUTION: DO NOT OPERATE THE DRAIN VALVE UNLESS THE FLOAT INDICATES WATER CONTENT. EQUIPMENT MAY BE DAMAGED IF SPILLAGE OCCURS.

1. Inspect the drain valve; if a water content is indicated, drain into a suitable container.



Water Drain Valve

Figure 101

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OXYGEN

General

The oxygen system supplies gaseous oxygen to the crew and passengers if decompression occurs and for therapeutic purposes. Oxygen cylinders are mounted underfloor in the forward fuselage, one in the electrics bay and, in aircraft with automatic presentation passenger systems, two in the electronics bay.

From the cylinders the oxygen is piped through in-line filters to the control panel in the flight deck right-hand console.

FLIGHT CREW

Some Models have an 'on demand' system, others have an automatic presentation system.

The control panel for the 'on demand' system comprises a slow-opening shut-off valve, a pressure reducing regulator and a system pressure gauge. The control panel connects to demand regulators and masks. Each demand regulator has an ON/OFF switch, a NORMAL/100% switch and an EMERGENCY switch.

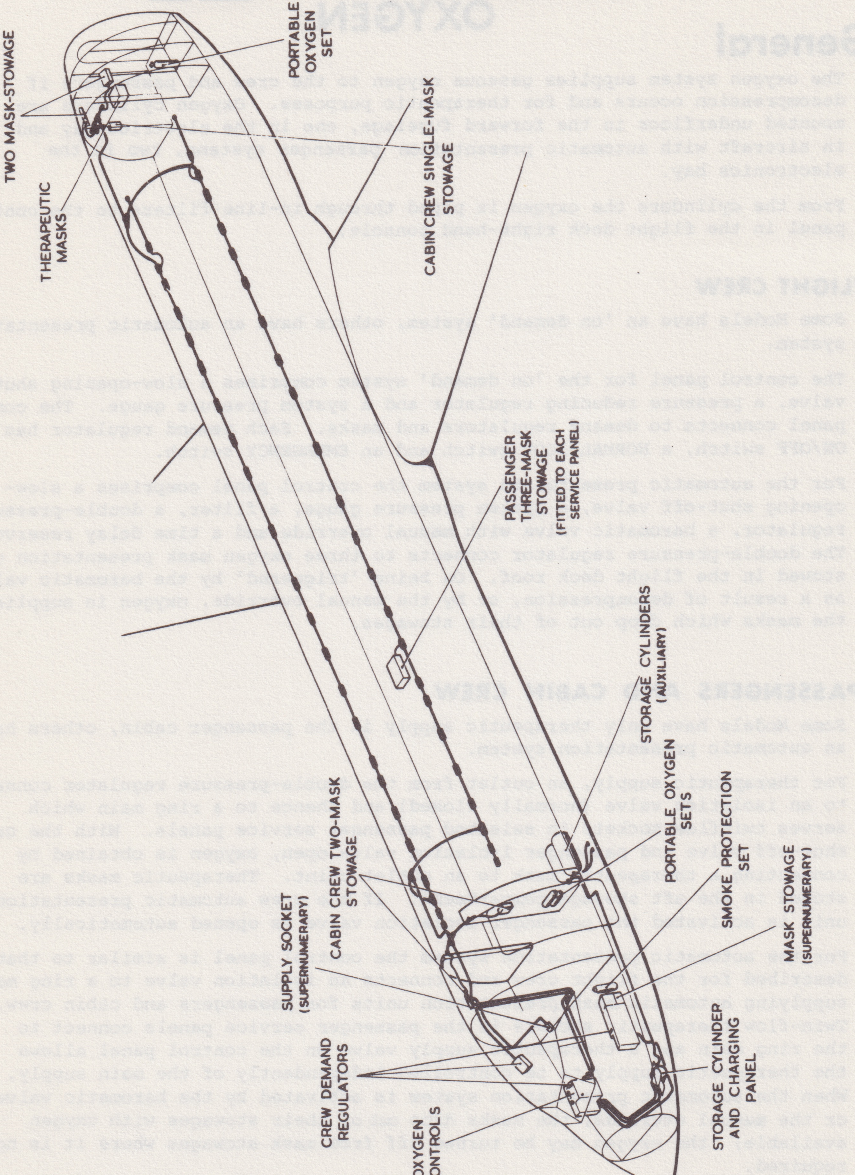
For the automatic presentation system the control panel comprises a slow-opening shut-off valve, a system pressure gauge, a filter, a double-pressure regulator, a baromatic valve with manual override and a time delay reservoir. The double-pressure regulator connects to three oxygen mask presentation units stowed in the flight deck roof. On being 'triggered' by the baromatic valve, as a result of decompression, or by the manual override, oxygen is supplied to the masks which drop out of their stowages.

PASSENGERS AND CABIN CREW

Some Models have only therapeutic supply in the passenger cabin, others have an automatic presentation system.

For therapeutic supply, an outlet from the double-pressure regulator connects to an isolation valve (normally closed) and thence to a ring main which serves twinflow sockets in selected passenger service panels. With the crew shut-off valve and passenger isolation valve open, oxygen is obtained by connecting a therapeutic mask to an outlet point. Therapeutic masks are stowed in the aft stowage compartment. If the crew automatic presentation unit is activated the passenger isolation valve is opened automatically.

For the automatic presentation system the control panel is similar to that described for the flight crew and connects an isolation valve to a ring main supplying automatic mask presentation units for passengers and cabin crew. Twin-flow therapeutic sockets in the passenger service panels connect to the ring main and a therapeutic supply valve on the control panel allows the therapeutic supply to be controlled independently of the main supply. When the automatic presentation system is activated by the baromatic valve, or the manual override, the masks drop out of their stowages with oxygen available; the oxygen may be turned off from mask stowages where it is not required.


PORTABLE OXYGEN SET
TWO MASK-STOWAGE
THERAPEUTIC MASKS
CABIN CREW SINGLE-MASK STOWAGE
PASSENGER THREE-MASK STOWAGE (FITTED TO EACH SERVICE PANEL)
STORAGE CYLINDERS (AUXILIARY)
PORTABLE OXYGEN SETS
SMOKE PROTECTION SET
MASK STOWAGE (SUPERNUMERARY)
STORAGE CYLINDER AND CHARGING PANEL
SUPPLY SOCKET (SUPERNUMERARY)
CABIN CREW TWO-MASK STOWAGE
CREW DEMAND REGULATORS
OXYGEN CONTROLS
XAB35/445

Typical General Arrangement of Oxygen System
Figure 1

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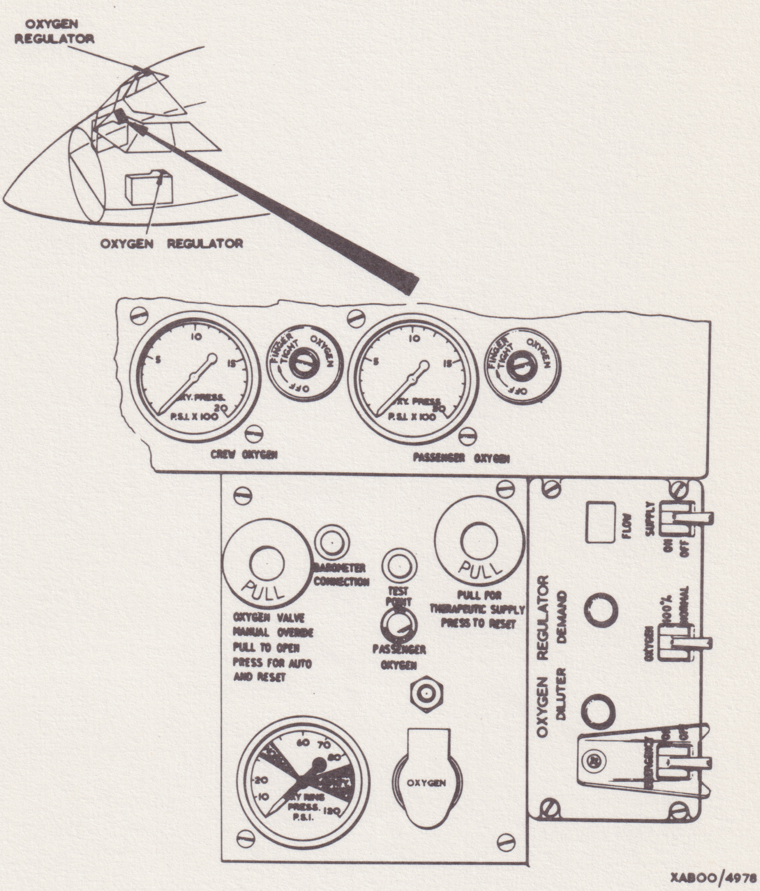
B0 6317


OXYGEN REGULATOR
OXYGEN REGULATOR
CREW OXYGEN
PASSENGER OXYGEN
FINGER TIGHT
OXYGEN
OFF
P.S.I. X 100
PULL
BAROMETER CONNECTION
OXYGEN VALVE MANUAL OVERIDE PULL TO OPEN PRESS FOR AUTO AND RESET
TEST POINT
PASSENGER OXYGEN
PULL
PULL FOR THERAPEUTIC SUPPLY PRESS TO RESET
PRESS. P.S.I.
OXYGEN
OXYGEN REGULATOR
DILUTER DEMAND
FLOW
SUPPLY
ON OFF
OXYGEN
100%
NORMAL
EMERGENCY
ON OFF
XAB00/4978

Typical Controls and Indicators
Figure 2

OXYGEN - SERVICING

General

The system storage cylinders are recharged in situ from a ground servicing unit.

Access to the charging panel is through the electrics bay door beneath the aircraft nose.

Portable oxygen cylinders are located, one on the flight deck left console and one near each cabin attendants seat. These should be renewed when their contents gauges read less than full.

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PRECAUTIONS

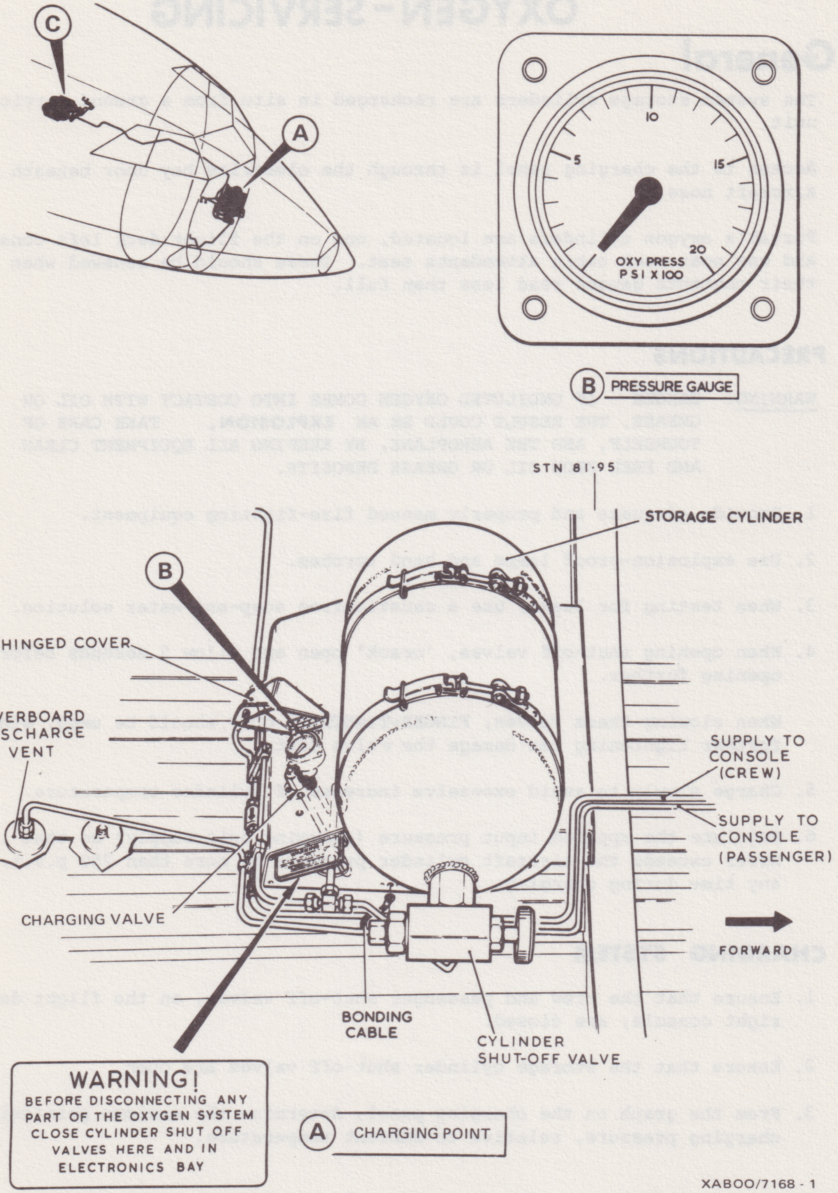
WARNING: DANGER - IF UNDILUTED OXYGEN COMES INTO CONTACT WITH OIL OR GREASE, THE RESULT COULD BE AN **EXPLOSION.** TAKE CARE OF YOURSELF, AND THE AEROPLANE, BY KEEPING ALL EQUIPMENT CLEAN AND FREE FROM OIL OR GREASE DEPOSITS.

1. Provide adequate and properly manned fire-fighting equipment.
2. Use explosion-proof lamps and hand torches.
3. When testing for leaks, use a caustic-free soap-and-water solution.
4. When opening shut-off valves, 'crack' open and allow 5 seconds before opening further.

   When closing these valves, FINGER-TIGHTNESS only should be used, since further tightening can damage the valve seats.
5. Charge slowly to avoid excessive increase of cylinder temperature.
6. Regulate the applied input pressure (charging unit supply) so that it never exceeds the aircraft cylinder pressure by more than 250 p.s.i., at any time during charging.

CHARGING SYSTEM

1. Ensure that the crew and passenger shut-off valves, on the flight deck right console, are closed.
2. Ensure that the storage cylinder shut-off valves are open.
3. From the graph on the charging panel, determine the maximum permissible charging pressure, relative to ambient temperature.


C
A
10
5
15
20
OXY PRESS
PSI X 100
B PRESSURE GAUGE
STN 81·95
STORAGE CYLINDER
B
HINGED COVER
OVERBOARD DISCHARGE VENT
SUPPLY TO CONSOLE (CREW)
SUPPLY TO CONSOLE (PASSENGER)
CHARGING VALVE
FORWARD
BONDING CABLE
CYLINDER SHUT-OFF VALVE
WARNING!
BEFORE DISCONNECTING ANY PART OF THE OXYGEN SYSTEM CLOSE CYLINDER SHUT OFF VALVES HERE AND IN ELECTRONICS BAY
A CHARGING POINT
XABOO/7168 - 1

Typical Rechargeable Oxygen System (1)

Figure 101

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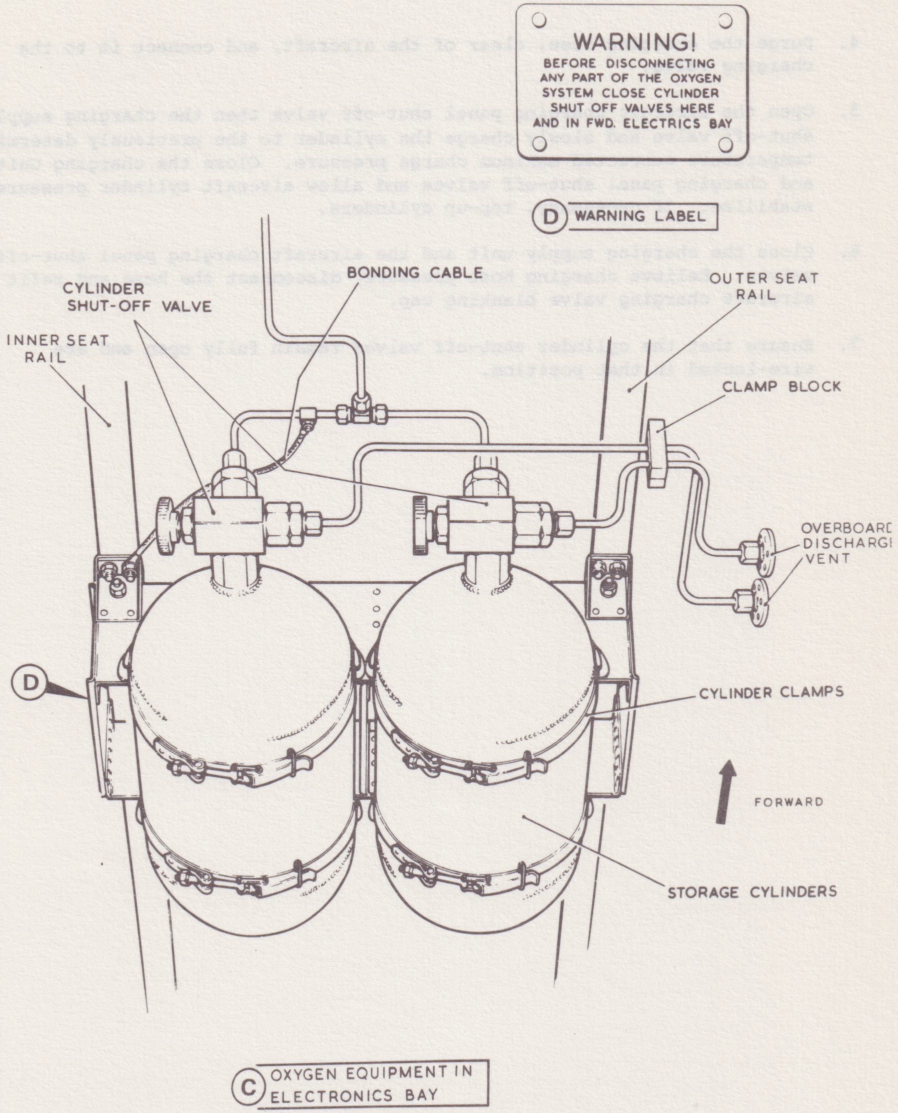
WARNING!
BEFORE DISCONNECTING ANY PART OF THE OXYGEN SYSTEM CLOSE CYLINDER SHUT OFF VALVES HERE AND IN FWD. ELECTRICS BAY
D WARNING LABEL
BONDING CABLE
CYLINDER SHUT-OFF VALVE
OUTER SEAT RAIL
INNER SEAT RAIL
CLAMP BLOCK
OVERBOARD DISCHARGE VENT
D
CYLINDER CLAMPS
FORWARD
STORAGE CYLINDERS
C OXYGEN EQUIPMENT IN ELECTRONICS BAY

XABOO/7168 - 2

Typical Rechargeable Oxygen System (2)
Figure 102

4. Purge the charging hose, clear of the aircraft, and connect it to the charging valve.

5. Open the aircraft charging panel shut-off valve then the charging supply shut-off valve and slowly charge the cylinder to the previously determined temperature corrected maximum charge pressure. Close the charging unit and charging panel shut-off valves and allow aircraft cylinder pressure to stabilize. If necessary, top-up cylinders.

6. Close the charging supply unit and the aircraft charging panel shut-off valves. Relieve charging hose pressure, disconnect the hose and refit the aircraft charging valve blanking cap.

7. Ensure that the cylinder shut-off valves remain fully open and are wire-locked in that position.

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WATER/WASTE

General

A self-priming water system supplies potable water, under pressure to the toilet wash basins. On most Models, the galleys also are supplied from the system. Those not so supplied have self-contained water systems with individual tanks and filling points.

Waste water from galleys and toilet basins is discharged to atmosphere. Toilet waste is retained in tanks for disposal during ground servicing.

Pressurized air operates the water supply and water closet flushing systems.

WATER SYSTEM

An air pressurized 20 Imp.gallon (24 U.S.gallon, 91 litre) tank, in the forward equipment bay, supplies cold water to toilet wash basin, galley services and water heaters. Vent valves connected to the top of the water heaters ensure automatic priming of the toilet supply lines; galley services require manual priming.

A manually-operated ISOLATING VALVE, on the right-hand side of the flight-deck vestibules can be used to cut off the water supply to the toilets, galley or the whole system in the event of a fault.

The electrically-operated water heaters in the stowage compartments aft of the toilets, supply the toilet wash basins and are thermostatically-controlled at 60 deg.C (140 deg.F). The heaters, controlled by an ON/OFF switch on the forward stewards panel, have overheat cut-outs which require resetting manually. In the supply tank is a float switch in circuit with a lamp on the forward stewards panel and another in the water servicing box. The lamps light at a falling water level of 8 Imp.gallons (10 U.S. gallons, 36 litres) and remain lit until the level is restored to 20 Imp. gallons.

The supply tank has a multi-way fill valve and drain valve, manually controlled from the domestic water servicing box. Service piping connects each valve to the FILL, OVERFLOW and DRAIN connections in the servicing box.

With the fill valve in the open (fill) position, the tank is vented to atmosphere and may be replenished. With the valve in the closed (flight) position, servicing ports are isolated and the air pressure supply port reopened.

Provision is made, by manually-operated valves, to drain the water heaters amd pipe lines.

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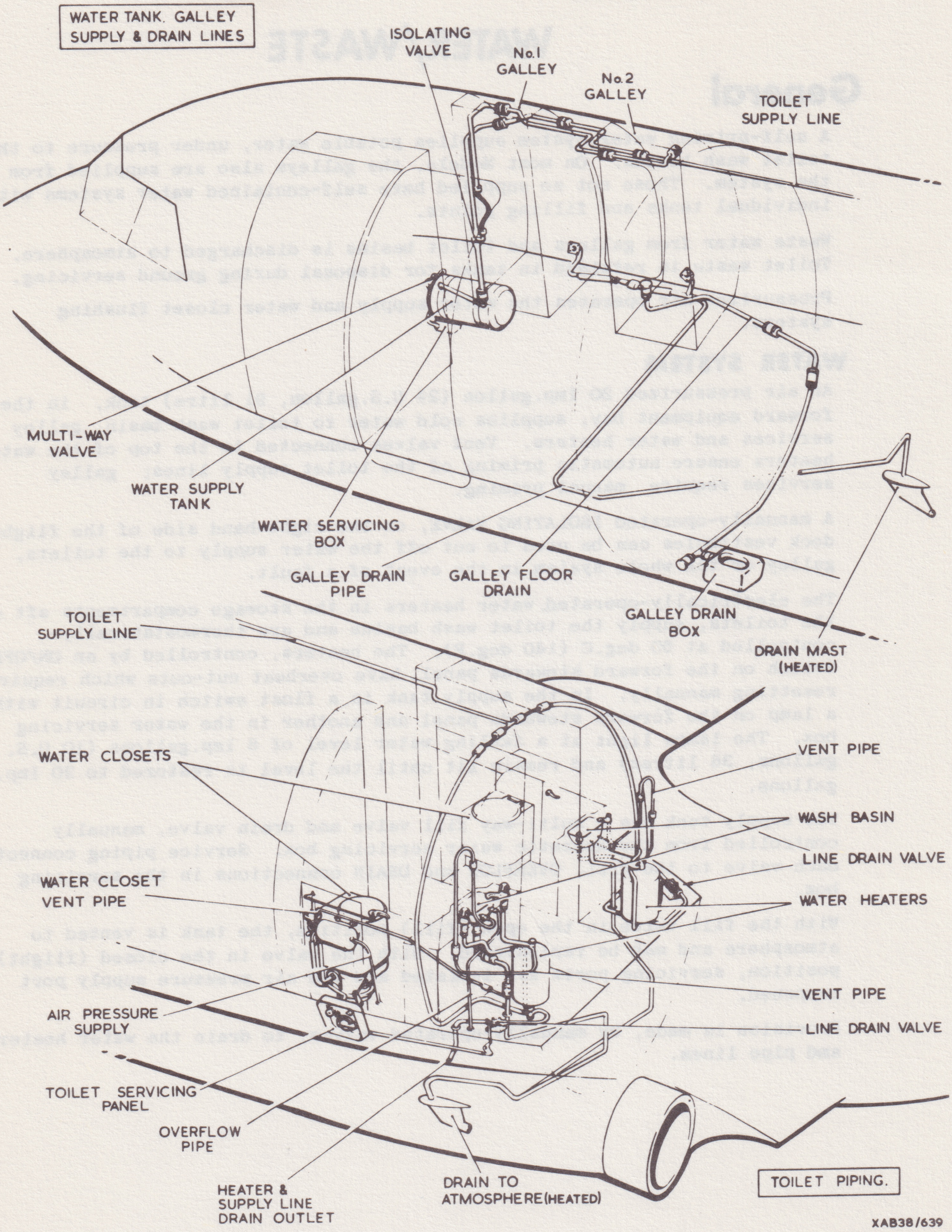
WATER TANK. GALLEY SUPPLY & DRAIN LINES
ISOLATING VALVE
No.1 GALLEY
No.2 GALLEY
TOILET SUPPLY LINE
MULTI-WAY VALVE
WATER SUPPLY TANK
WATER SERVICING BOX
GALLEY DRAIN PIPE
GALLEY FLOOR DRAIN
GALLEY DRAIN BOX
DRAIN MAST (HEATED)
TOILET SUPPLY LINE
WATER CLOSETS
VENT PIPE
WASH BASIN
LINE DRAIN VALVE
WATER CLOSET VENT PIPE
WATER HEATERS
VENT PIPE
AIR PRESSURE SUPPLY
LINE DRAIN VALVE
TOILET SERVICING PANEL
OVERFLOW PIPE
HEATER & SUPPLY LINE DRAIN OUTLET
DRAIN TO ATMOSPHERE (HEATED)
TOILET PIPING.
XAB38/639

Typical G.A. of Water and Waste Systems
Figure 1

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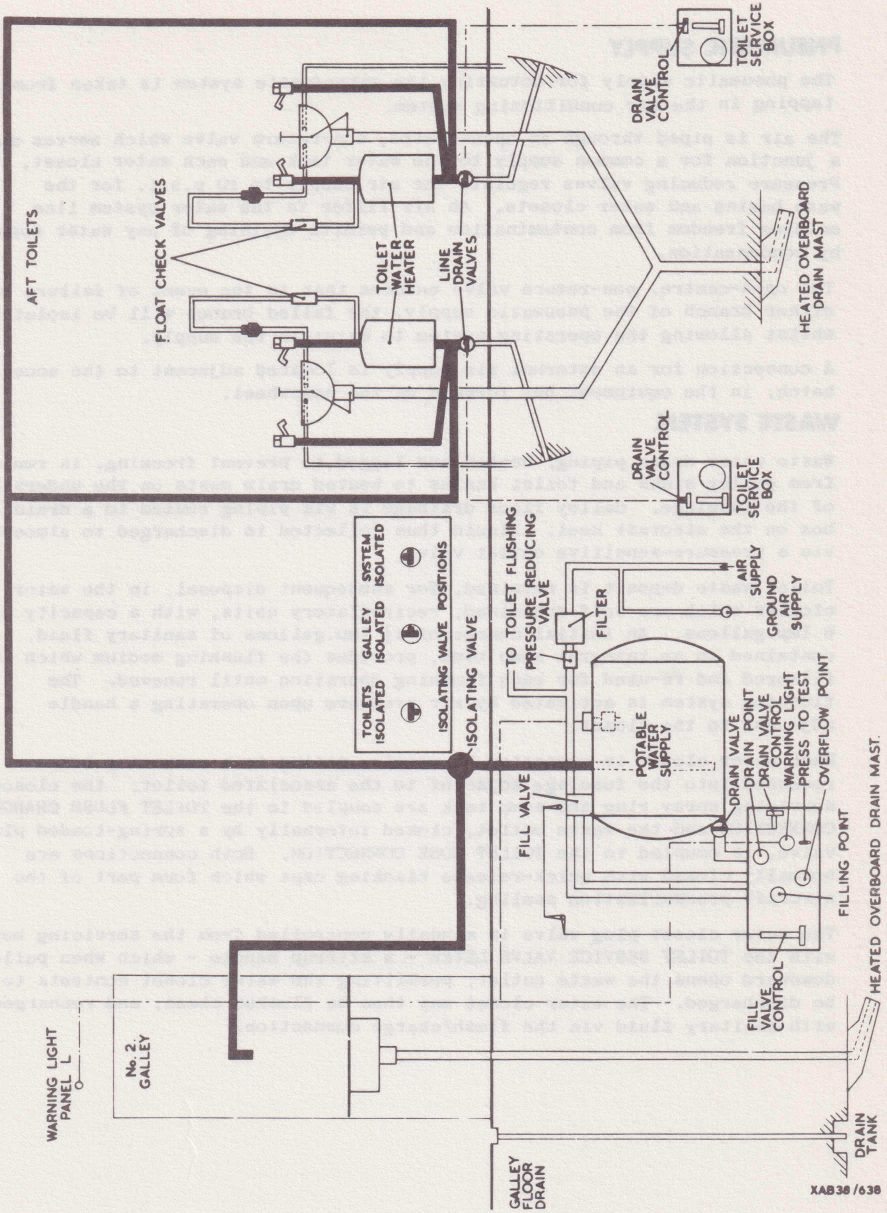

TOILET SERVICE BOX
DRAIN VALVE CONTROL
AFT TOILETS
FLOAT CHECK VALVES
TOILET WATER HEATER
LINE DRAIN VALVES
HEATED OVERBOARD DRAIN MAST
DRAIN VALVE CONTROL
TOILET SERVICE BOX
SYSTEM ISOLATED
GALLEY ISOLATED
TOILETS ISOLATED
ISOLATING VALVE POSITIONS
ISOLATING VALVE
TO TOILET FLUSHING PRESSURE REDUCING VALVE
FILTER
AIR SUPPLY
GROUND AIR SUPPLY
POTABLE WATER SUPPLY
FILL VALVE
DRAIN VALVE
DRAIN POINT
DRAIN VALVE CONTROL
WARNING LIGHT PRESS TO TEST
OVERFLOW POINT
FILLING POINT
HEATED OVERBOARD DRAIN MAST.
FILL VALVE CONTROL
WARNING LIGHT PANEL L
No. 2. GALLEY
GALLEY FLOOR DRAIN
DRAIN TANK
XAB38/638

Typical Water Supply and Drains Diagram
Figure 2

PNEUMATIC SUPPLY

The pneumatic supply for actuating the water/waste system is taken from a tapping in the air conditioning system.

The air is piped through an open-centre, non-return valve which serves as a junction for a common supply to the water tank and each water closet. Pressure reducing valves regulate the air supply to 10 p.s.i. for the wash basins and water closets. An air filter in the water system line ensures freedom from contamination and permits draining of any water formed by condensation.

The open-centre, non-return valve ensures that in the event of failure of either branch of the pneumatic supply, the failed branch will be isolated, whilst allowing the operating system to maintain the supply.

A connection for an external air supply is located adjacent to the access hatch, in the equipment bay forward of the nosewheel.

WASTE SYSTEM

Waste water drain piping, heated and lagged to prevent freezing, is routed from galley sinks and toilet basins to heated drain masts on the underside of the fuselage. Galley floor drainage is via piping routed to a drain box on the aircraft keel; liquid thus collected is discharged to atmosphere via a pressure-sensitive outlet valve.

Toilet waste deposit is retained, for subsequent disposal, in the water closets which are self-contained, recirculatory units, with a capacity of 6 Imp.gallons. An initial charge of $1\frac{1}{2}$ Imp.gallons of sanitary fluid, contained in an integral sump tank, provides the flushing medium which is filtered and re-used for each flushing operation until renewed. The flushing system is activated by air pressure upon operating a handle adjacent to the closet.

Each water closet is connected by service piping to a servicing box recessed into the fuselage adjacent to the associated toilet; the closet servicing spray ring and sump tank are coupled to the TOILET FLUSH CHARGE CONNECTION and the waste outlet, closed internally by a spring-loaded plug valve, is coupled to the TOILET HOSE CONNECTION. Both connections are normally closed with quick-release blanking caps which form part of the aircraft pressurization sealing.

The water closet plug valve is manually controlled from the servicing box with the TOILET SERVICE VALVE LEVER - a stirrup handle - which when pulled downward opens the waste outlet, permitting the water closet contents to be discharged. The water closet may then be flushed clean, and recharged with sanitary fluid via the flush/charge connection.

WATER/WASTE-SERVICING

General

Servicing of the domestic water and waste systems requires no special equipment, other than that normally available.

The water system is pressure-filled, via an external servicing point.

Toilet closets are serviced from separate external boxes, and this may be by using a ground servicing unit, or alternatively by manual methods when ground facilities are not available.

Procedures herein do not take into account certain specific exceptions; for example, the individual replenishment of galley self-contained water systems. When servicing such aircraft, all reference to the opening of galley water taps should of course, be disregarded.

For servicing of the water injection system, see Section 4-4-0.

WATER SYSTEM

NOTE: When the low water contents lamp on the forward stewards panel and/or the servicing box is lit, less than 8 Imp.gallons remain.

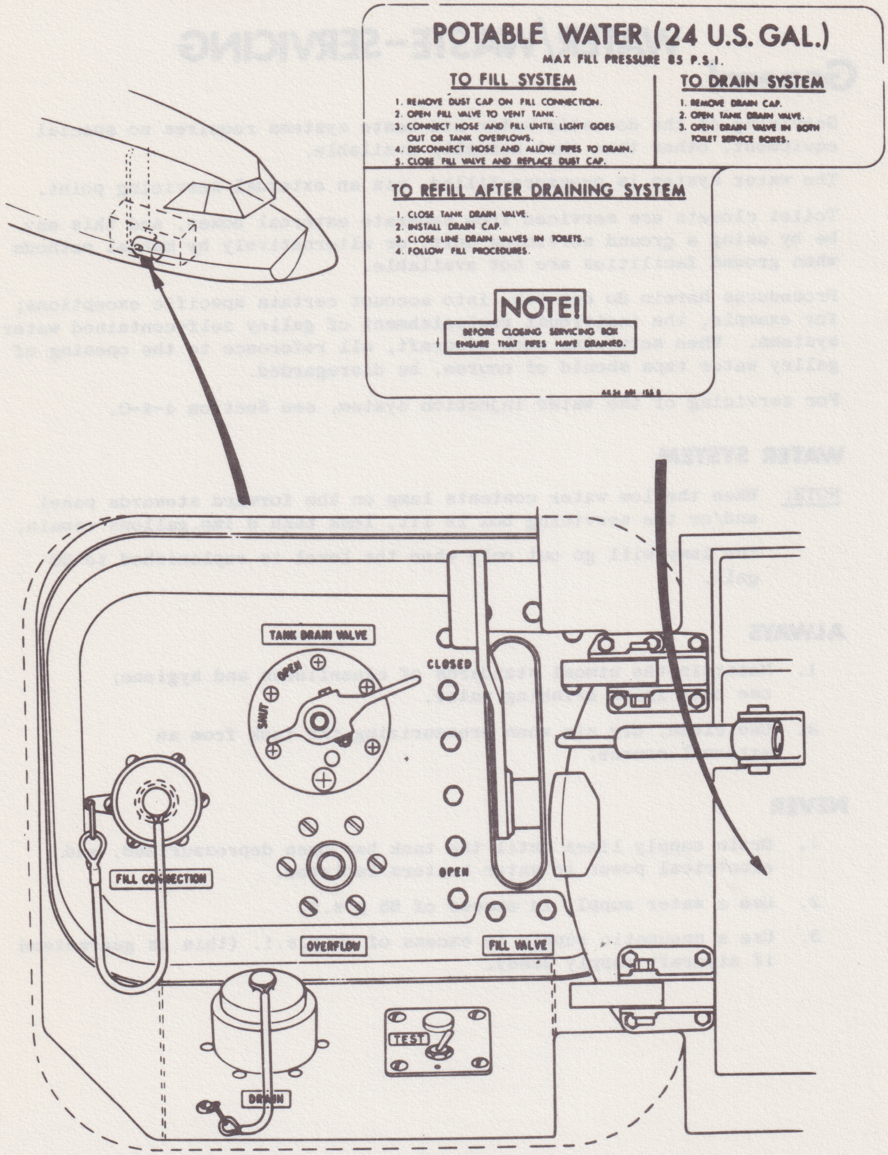
The lamp will go out only when the level is replenished to 20 gall.

ALWAYS

1. Maintain the utmost standards of cleanliness and hygiene; use only fresh drinking water.
2. Use clean, dry air when pressurizing the tank from an external source.

NEVER

1. Drain supply lines until the tank has been depressurized, and electrical power to water heaters isolated.
2. Use a water supply in excess of 85 p.s.i.
3. Use a pneumatic supply in excess of 40 p.s.i. (this is guaranteed if aircraft supply used).



POTABLE WATER (24 U.S. GAL.)

MAX FILL PRESSURE 85 P.S.I.

TO FILL SYSTEM

1. REMOVE DUST CAP ON FILL CONNECTION.
2. OPEN FILL VALVE TO VENT TANK.
3. CONNECT HOSE AND FILL UNTIL LIGHT GOES OUT OR TANK OVERFLOWS.
4. DISCONNECT HOSE AND ALLOW PIPES TO DRAIN.
5. CLOSE FILL VALVE AND REPLACE DUST CAP.

TO DRAIN SYSTEM

1. REMOVE DRAIN CAP.
2. OPEN TANK DRAIN VALVE.
3. OPEN DRAIN VALVE IN BOTH TOILET SERVICE BOXES.

TO REFILL AFTER DRAINING SYSTEM

1. CLOSE TANK DRAIN VALVE.
2. INSTALL DRAIN CAP.
3. CLOSE LINE DRAIN VALVES IN TOILETS.
4. FOLLOW FILL PROCEDURES.

NOTE!

BEFORE CLOSING SERVICING BOX ENSURE THAT PIPES HAVE DRAINED.

AE34 681 155 B
TANK DRAIN VALVE
OPEN
SHUT
CLOSED
FILL CONNECTION
OPEN
OVERFLOW
FILL VALVE
TEST
DRAIN
XAB12/340

Typical Water System Servicing Box
(See Fig.102 for Line Drain Lever)
Figure 101

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REPLENISHING TANK (Fig.101)

1. Set the ISOLATING VALVE to NORMAL
2. Check the low contents light on the servicing panel. If out, operate the test switch to prove, and renew lamp if necessary.
3. Check that the TANK DRAIN valve is set to CLOSED.
4. Connect water servicing hoses to the FILL and OVERFLOW couplings, move FILL VALVE lever to the OPEN position and replenish until the low contents light goes out, or to overflow.

   NOTE: If the tank is filled to overflow and a water eliminating valve is not fitted, drain off two gallons.
5. Move the FILL VALVE lever to CLOSED position, allow surplus water to drain, and disconnect the hoses.
6. Refit blanking caps, wipe the servicing box dry and close its door.

DRAINING TANK (Fig.101)

1. Set the ISOLATING VALVE to NORMAL.
2. Connect a water servicing unit to the DRAIN coupling.
3. Open the TANK DRAIN VALVE: if the tank is air-pressurized, rapid draining will commence; if not, move the FILL VALVE lever to the OPEN position, so venting the tank.

DRAINING SUPPLY LINES (Figs.101 and 102)

NOTE: Supply lines can be drained with the water tank full.

1. Switch off the water heater and/or trip its circuit-breaker (flight deck panel B).
2. Move the FILL VALVE lever to the open position to depressurize the water tank.
3. Set ISOLATING VALVE to NORMAL.
4. In each toilet servicing box, open the DOMESTIC WATER DRAIN VALVE. Open toilet taps, and galley taps where applicable.

PRIMING WATER SYSTEM (Figs.101 and 102)

NOTE: Toilet water heaters and their supply lines are self-priming.

1. If necessary, replenish the water tank.
2. Set the ISOLATING VALVE to NORMAL, FILL VALVE to closed and line drain valves to closed.

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3. Pressurize the water tank using the aircraft air supply, or by an external air supply to the charging valve in the forward equipment bay.
4. Open the water taps in the toilets and galleys (where applicable) until a constant water flow is obtained.
5. Shut off air supply and close all access panels.

STERILIZING

If, for any reason the water system is suspected of being contaminated, it must be sterilized by thoroughly purging with an adequate chlorinating-fluid/water solution (See Table 101).

Allow 30 minutes for the fluid and water to mix, and a further 30 minutes in the system for complete sterilization.

DESCRIPTION	QUANTITY/DILUTION	SUPPLIER
Domestos	1¼ pints (1/500)	Thos. Hedley & Sons, Hanworth Park, Feltham, Middlesex, England.
Lacine (Pink)	¼ pint (1/2500)	T. Evershed & Sons, Dolphine Road, Shoreham, Sussex, England.

Chlorinating Fluids
Table 101

WASTE SYSTEM

ALWAYS

1. Stand clear when removing the toilet drain cap.
2. When using an external air source, use clean dry air and isolate the water tank by opening its fill valve.
3. Replace all blanking caps after servicing; they form part of the aircraft pressurization system.

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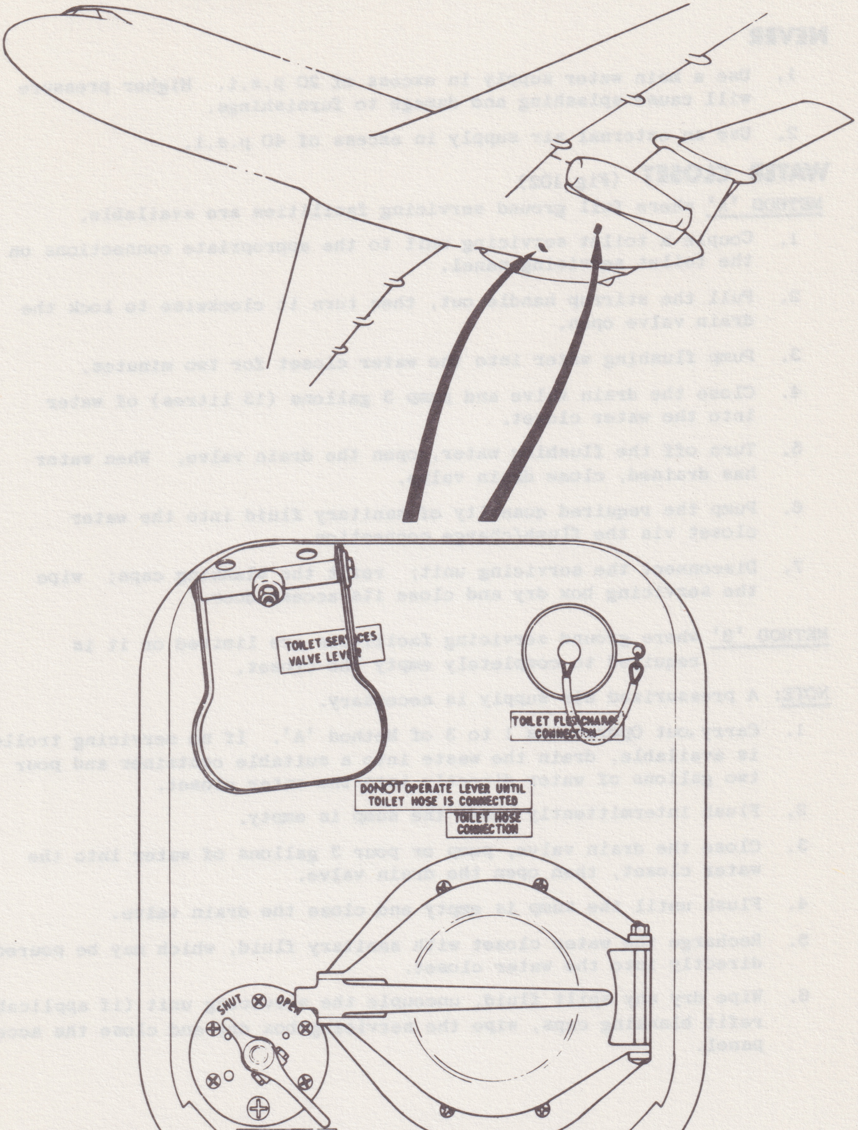

TOILET SERVICES VALVE LEVER
TOILET FLUSH CHARGE CONNECTION
DO NOT OPERATE LEVER UNTIL TOILET HOSE IS CONNECTED
TOILET HOSE CONNECTION
SHUT
OPEN
DOMESTIC WATER LINE DRAIN LEVER

XAB12/339

Typical Toilet Servicing Box

Figure 102

NEVER

1. Use a main water supply in excess of 20 p.s.i. Higher pressure will cause splashing and damage to furnishings.
2. Use an external air supply in excess of 40 p.s.i.

WATER CLOSET (Fig. 102)

METHOD 'A' where full ground servicing facilities are available.

1. Couple a toilet servicing unit to the appropriate connections on the toilet servicing panel.
2. Pull the stirrup handle out, then turn it clockwise to lock the drain valve open.
3. Pump flushing water into the water closet for two minutes.
4. Close the drain valve and pump 3 gallons (13 litres) of water into the water closet.
5. Turn off the flushing water, open the drain valve, When water has drained, close drain valve.
6. Pump the required quantity of sanitary fluid into the water closet via the flush/charge connection.
7. Disconnect the servicing unit; refit the blanking caps; wipe the servicing box dry and close its access door.

METHOD 'B' where ground servicing facilities are limited or it is required to completely empty the closet.

NOTE: A pressurized air supply is necessary.

1. Carry out Operations 1 to 3 of Method 'A'. If no servicing trolley is available, drain the waste into a suitable container and pour two gallons of water directly into the water closet.
2. Flush intermittently until the sump is empty.
3. Close the drain valve, pump or pour 3 gallons of water into the water closet, then open the drain valve.
4. Flush until the sump is empty and close the drain valve.
5. Recharge the water closet with sanitary fluid, which may be poured directly into the water closet.
6. Wipe dry any spilt fluid, uncouple the servicing unit (if applicable), refit blanking caps, wipe the servicing box dry and close the access panel.

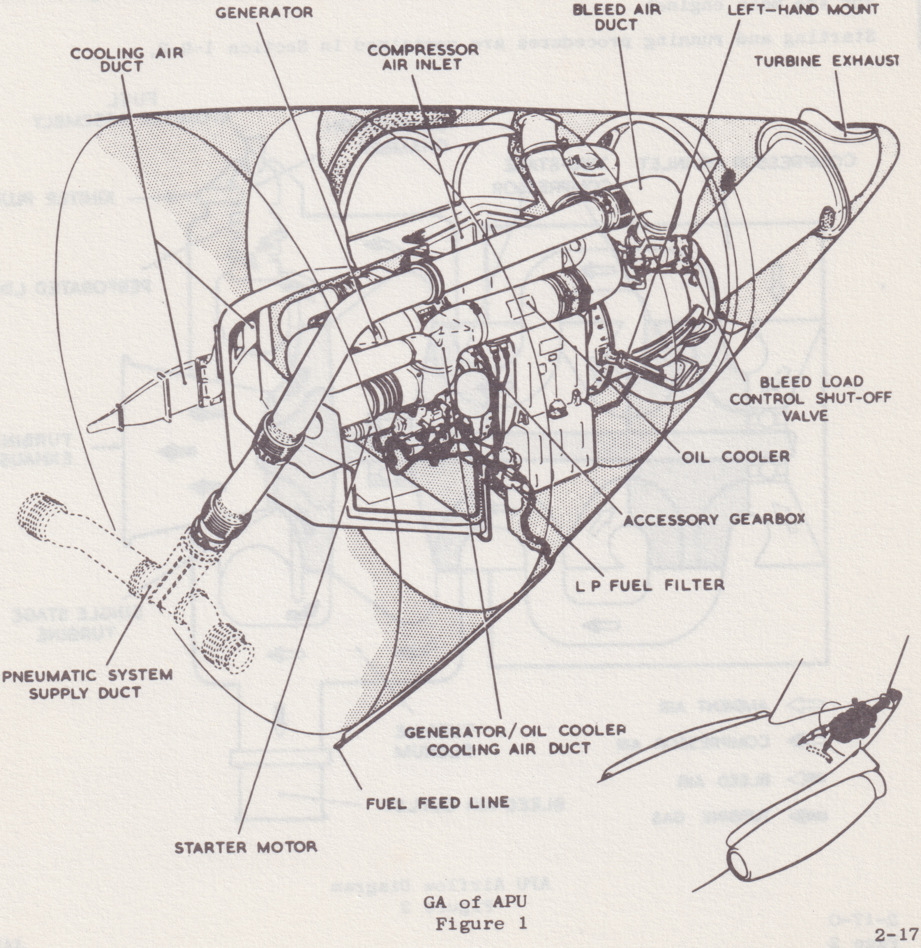
ENGINEERS POCKETBOOK
BAC ONE-ELEVEN

AIRBORNE AUXILIARY POWER

General

The auxiliary power unit (APU) installed in early 500 Series variants is the Type G.C.T.P 85-115C, to which this section is basically related.

Later variants are equipped with the Type G.C.T.P.85-CK, which may be retrospectively fitted subject to embodiment of associated system modifications, and appropriate reference is included herein.


GENERATOR
BLEED AIR DUCT
LEFT-HAND MOUNT
COOLING AIR DUCT
COMPRESSOR AIR INLET
TURBINE EXHAUST
BLEED LOAD CONTROL SHUT-OFF VALVE
OIL COOLER
ACCESSORY GEARBOX
L P FUEL FILTER
PNEUMATIC SYSTEM SUPPLY DUCT
GENERATOR/OIL COOLER COOLING AIR DUCT
FUEL FEED LINE
STARTER MOTOR

GA of APU
Figure 1

However, it should be appreciated that each type is supported by the manufacturer's modification programme which is monitored and reflected in detail in the mandatory manuals.

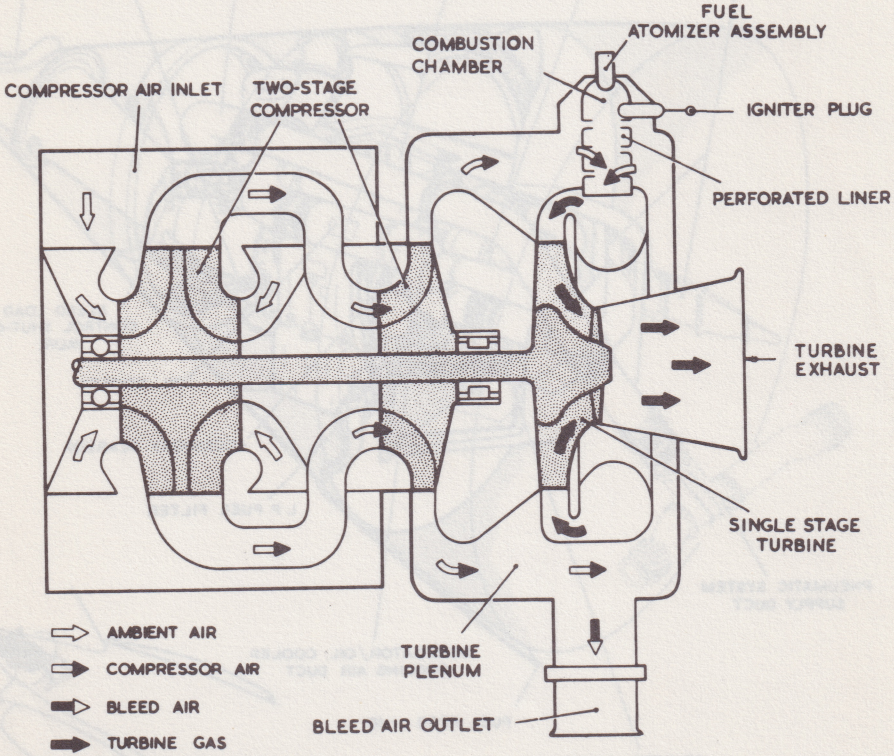
PRINCIPAL DIFFERENCES

The most significant difference between types is that Type 115CK is further developed to run at a lower operating temperature, which prolongs engine life.

The APU comprises a simple gas turbine engine, an accessory gearbox and associated units together with a bleed air duct and control system.

The unit will supply pneumatic power to the aircraft integrated air system and generate power for the electrical system, thus it enables the aircraft to operate independent of ground power sources and provides an in-flight re-light facility for the main engines.

Starting and running procedures are contained in Section 1-9-2,


FUEL ATOMIZER ASSEMBLY
COMBUSTION CHAMBER
COMPRESSOR AIR INLET
TWO-STAGE COMPRESSOR
IGNITER PLUG
PERFORATED LINER
TURBINE EXHAUST
SINGLE STAGE TURBINE
TURBINE PLENUM
BLEED AIR OUTLET
AMBIENT AIR
COMPRESSOR AIR
BLEED AIR
TURBINE GAS

APU Airflow Diagram
Figure 2

The engine has a two-stage compressor and single-stage turbine assembly, which is connected to the accessory gearbox by coupled shafts. The combustion chamber, formed by an extension of the turbine plenum, is fitted with a perforated liner through which the fuel atomizer assembly and igniter plug protrude.

Upon initiation of the start cycle, a starter motor operating through the gearbox drive assembly, rotates the engine, drawing ambient air into the compressor air inlet, The air is passed through both compression stages, ducted into the turbine plenum, then directed through the perforated liner into the combustion chamber.
As engine r.p.m. increases, fuel is supplied to the atomizer assembly, the ignition unit is energised and the fuel/air mixture ignited. A proportion of the air is utilized to reduce the gas temperature to an acceptable level before it passes through a nozzle assembly to drive the turbine. From the turbine, the exhaust gasses are expelled to atmosphere through an exhaust assembly.

At predetermined speeds during engine acceleration, the ignition and starter motor systems are cancelled. Immediately prior to the engine attaining maximum governed speed, circuits to a start and running time meter are completed, and the bleed air delivery system is armed.

FUEL

The APU fuel system supplied directly from the left wing fuel tank, automatically ensures smooth acceleration to normal running speed, and thereafter modulates fuel flow to compensate for varying electrical and air bleed loads applied to the unit.

Fuel from the wing tank is passed through an LP shut-off valve and a LP booster pump, both fitted within the left wing, then pumped to the APU HP pump via a water drain valve fitted in the main undercarriage bay, and an LP fuel filter mounted on the left side of the APU forward bulkhead.

The LP fuel supply enters the HP pump and is pumped at high pressure, through an HP fuel filter to the fuel solenoid shut-off valve. A proportion of the HP fuel is diverted to the fuel governor, which maintains constant engine speed under varying load conditions. Both the HP pump and the fuel governor are driven by the accessory gearbox. Interconnected with the governor is a limiter valve, which controls acceleration by adjusting the HP fuel flow in relation to compressor outlet pressure and turbine exhaust gas temperature.

The fuel solenoid shut-off valve automatically opens, as oil pressure builds up, and permits HP fuel to flow to the atomizer assembly, which is mounted on the combustion chamber cap, and incorporates a flow divider valve.

During the early stages of acceleration, fuel is directed into the combustion chamber through the smaller of two atomizer ports. As the HP pump output and pressure increase with engine acceleration, the flow divider valve opens, directing the fuel through both ports, thus providing correct fuel atomization under all operating conditions.

At overtemperature conditions fuel flow is modulated by the combined action of an acceleration control thermostat and load control thermostat.

On aircraft embodying MOD.PM4438, this function is performed by a single, load control, thermostat.

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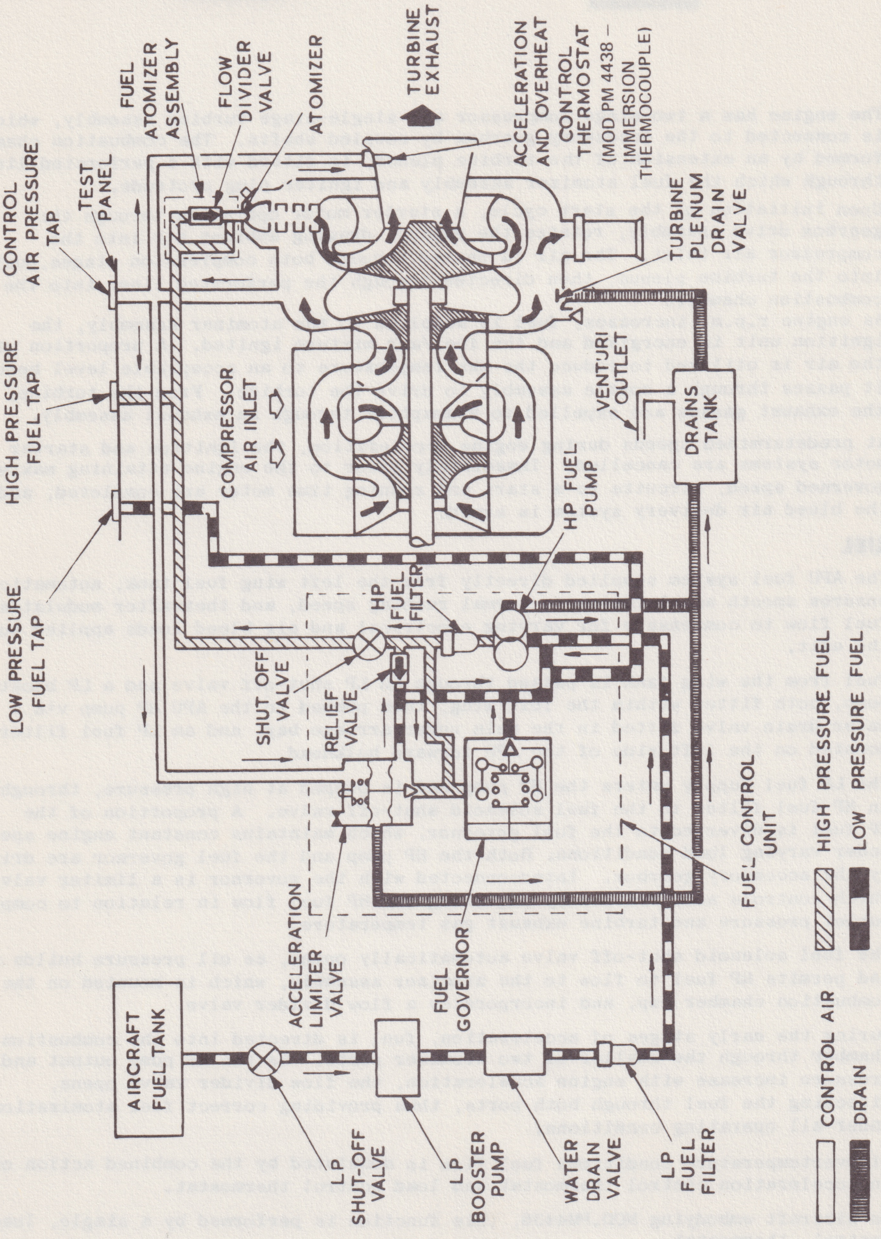
CONTROL AIR PRESSURE TAP
TEST PANEL
FUEL ATOMIZER ASSEMBLY
FLOW DIVIDER VALVE
ATOMIZER
TURBINE EXHAUST
ACCELERATION AND OVERHEAT CONTROL THERMOSTAT (MOD PM 4438 – IMMERSION THERMOCOUPLE)
TURBINE PLENUM DRAIN VALVE
VENTURI OUTLET
DRAINS TANK
HIGH PRESSURE FUEL TAP
COMPRESSOR AIR INLET
HP FUEL PUMP
LOW PRESSURE FUEL TAP
SHUT OFF VALVE
HP FUEL FILTER
RELIEF VALVE
FUEL CONTROL UNIT
ACCELERATION LIMITER VALVE
FUEL GOVERNOR
AIRCRAFT FUEL TANK
LP SHUT-OFF VALVE
LP BOOSTER PUMP
WATER DRAIN VALVE
LP FUEL FILTER
▨ HIGH PRESSURE FUEL
LOW PRESSURE FUEL
☐ CONTROL AIR
DRAIN

APU Fuel System
Figure 3

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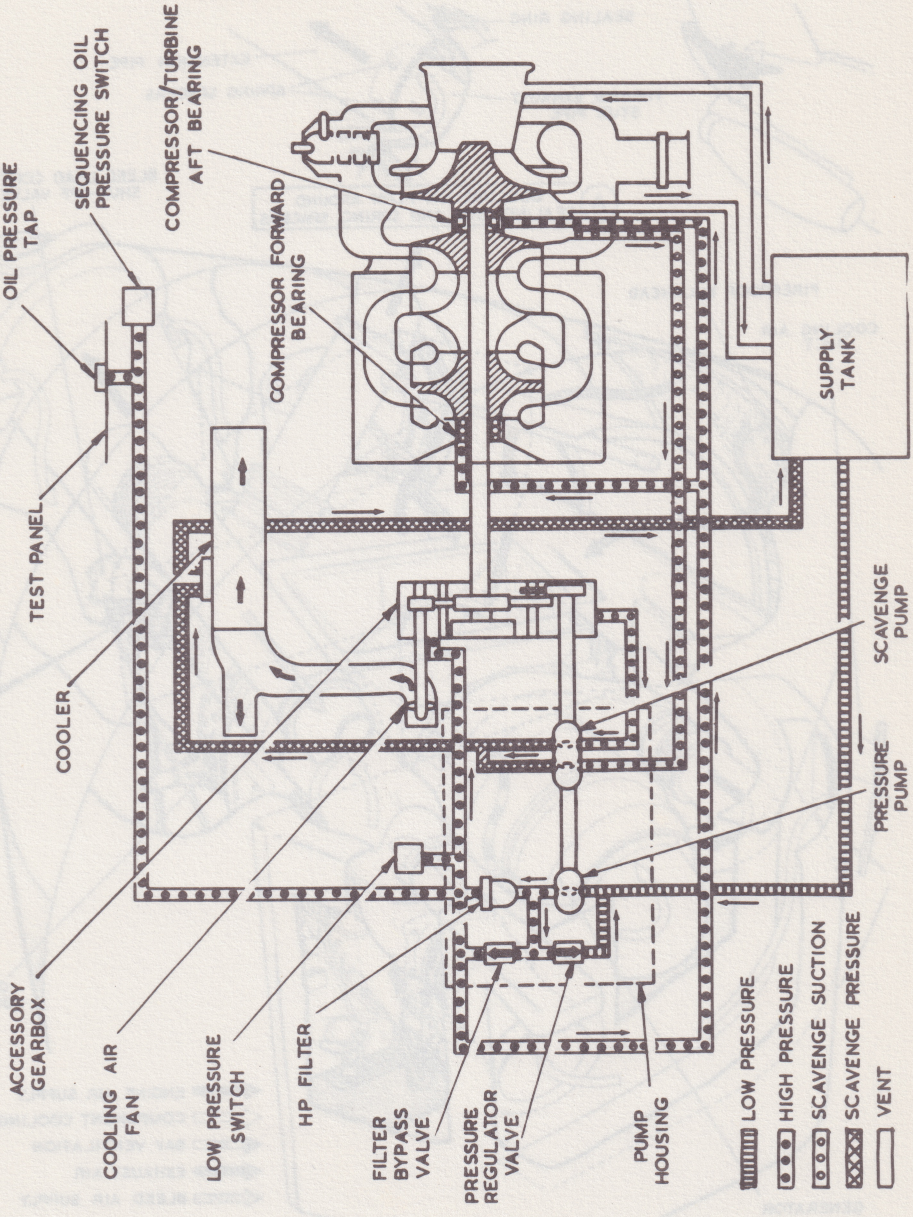
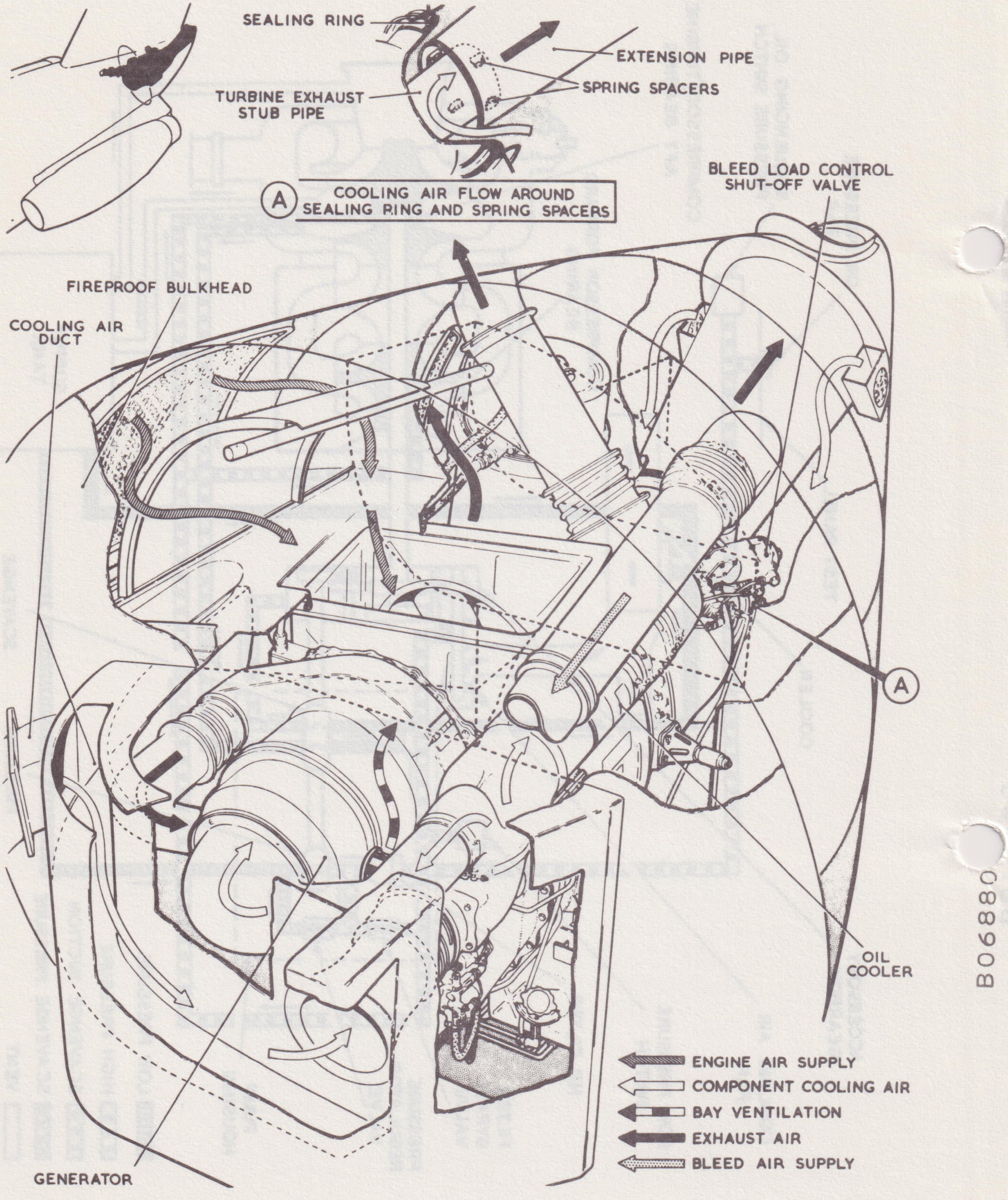

SEQUENCING OIL PRESSURE SWITCH
OIL PRESSURE TAP
TEST PANEL
COOLER
ACCESSORY GEARBOX
COOLING AIR FAN
LOW PRESSURE SWITCH
HP FILTER
FILTER BYPASS VALVE
PRESSURE REGULATOR VALVE
PUMP HOUSING
COMPRESSOR/TURBINE AFT BEARING
COMPRESSOR FORWARD BEARING
SUPPLY TANK
SCAVENGE PUMP
PRESSURE PUMP
LOW PRESSURE
HIGH PRESSURE
SCAVENGE SUCTION
SCAVENGE PRESSURE
VENT

APU Oil System
Figure 4


SEALING RING
EXTENSION PIPE
TURBINE EXHAUST STUB PIPE
SPRING SPACERS
Ⓐ COOLING AIR FLOW AROUND SEALING RING AND SPRING SPACERS
BLEED LOAD CONTROL SHUT-OFF VALVE
FIREPROOF BULKHEAD
COOLING AIR DUCT
Ⓐ
OIL COOLER
GENERATOR
ENGINE AIR SUPPLY
COMPONENT COOLING AIR
BAY VENTILATION
EXHAUST AIR
BLEED AIR SUPPLY
B06880

APU Air Circulation
Figure 5

A pnumatic power supply to the integrated air system is provided by compressed air bled from the turbine plenum. To prevent the engine exceeding normal operating temperatures through insufficient cooling, the quantity of compressed air taken from the plenum is governed by the bleed load control shut-off valve. The valve, mounted on the bleed air outlet duct, is controlled by a thermostat which meters the turbine exhaust temperature. Incorporated in the valve is the rate control assembly, which prevents momentary overload conditions by controlling the bleed air rate of flow through the outlet duct.

Cooling air, collected by a ram air intake mounted on the right-hand side of the fuselage, is passed through both the generator and the oil cooler then exhausted through ducts to atmosphere. A proportion of the cooling air is diverted from the generator inlet duct and directed into the engine bay for ventilation; after passing through the bay, the air is exhausted to atmosphere through an outlet situated at the rear of the tail cone. The exhaust bay is cooled by ambient air, which enters the rear of the tail cone through two inlet holes, then flows down to an air gap between the exhaust stub and exhaust extension pipes. The air is drawn into the exhaust gas flow and expelled to atmosphere in the jet efflux.

OIL

The APU incorporates a self-contained oil system, which provides either pressure or splash lubrication for all gears and bearings within the unit. With MOD.PM5053 embodied, failure of the system pressure will result in immediate automatic shut-down of the APU. The oil is circulated by a pressure pump and a scavenge pump, fitted within a common housing, and driven by the adjacent accessory gearbox.

Supply oil is drawn by the pressure pump from a tank mounted on the left-hand side of the APU, passed through a filter, and directed at high pressure through feed pipes and jets to the accessory gearbox, the compressor forward bearing, and the compressor/turbine aft bearing. If the filter becomes blocked the pressurized oil is passed for distribution through a filter bypass valve.

Scavenge pump suction returns the oil from the accessory gearbox and compressor/turbine aft bearing, via the oil cooler, to the tank where the scavenged oil/air mixture is passed through a centrifugal separator. Any air trapped in the system is vented into the turbine exhaust via the oil tank vent line. Due to the scavenge pump having a larger displacement than the pressure pump, a positive pressure is present within the oil tank whenever the APU is running.

If maximum system pressure is exceeded, a pressure regulator valve allows oil to return to the low pressure side of the pressure pump.

An oil pressure sequencing switch operates, during the start cycle, to energize and open the fuel solenoid shut-off valve when oil pressure reaches 3 p.s.i., thus the engine cannot start if the oil pressure system has failed.

Similarly, when the engine is running, the switch will initiate automatic shut-down should oil pressure fall below 3 p.s.i., except on aircraft with MOD.PM4260.

This modification was introduced basically to prevent inadvertent automatic shut-down from negative 'G'-induced momentary low oil pressure during airborne operation, and when embodied, the switch controls the fuel valve only during the start cycle, thus if low oil pressure occurs with the engine running it will continue to run until shut down manually, or automatically from overheat.

An oil low pressure switch operates whenever pressure is below 50 p.s.i. and illuminates the OIL LP warning lamp on the flight deck roof panel, thus the lamp comes on at commencement of the start cycle and remains lit until 50 p.s.i. is reached.

When MOD.PM5053 embodied, the switch will also initiate automatic shut-down in the event of oil pressure failure when the engine is running.

Overheat sensors in the tail cone cause automatic shut-down when responding to an overheat condition.

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A.P.U. - SERVICING

General

Access to all servicing points, except the oil tank drain plug, is through a door on the left side of the tail cone, shown on Fig.101. The drain plug is reached through a door below the unit.

APPROVED OILS

3 CENTISTOKE		5 CENTISTOKE (TYPE 11)			
Castrol	Aeroshell	Esso	Mobil	Chevron	Caltex
3C	Turbo 390	Turbo 2380	Jet 11	Jet 5	RPM Jet 5

Re-use of an approved oil is permitted only when such oil has been reclaimed to the standards of Rolls-Royce Spec. W.P.S.293 for 3 centistoke (British) or 15 centistoke (American) oils.

It is recommended that different proprietary brands are not intermixed.

OIL TANK CAPACITY	Imp.Pints	U.S.Pints	Litres
	6.7	8.0	3.8
CONSUMPTION			
Max. permissible/hour	0.75	0.90	0.40

CAUTION: (1) REFER TO CAUTIONS DETAILED ON PAGE 101 OF 'ENGINES - SERVICING'.

(2) DO NOT OVERFILL THE OIL TANK, OR OIL WILL PASS INTO THE EXHAUST STUB VIA THE ATMOSPHERE VENT.

CHECKING OIL LEVEL

1. Check the oil level by removing the gravity filler cap and reading its integral dipstick. If necessary, replenish using one of the two methods described below.

REPLENISHING - WITH PRESSURE CHARGING RIG (Fig.101)

1. Check oil level as described above.
2. Clean the APU and pressure rig connections and connect the pressure rig hose to the supply tank pressure filler.
3. Replenish with approved oil until the level reaches the MAX mark on the dipstick. Record the amount added.
4. Disconnect the pressure rig; replace the pressure filler and gravity filler caps.

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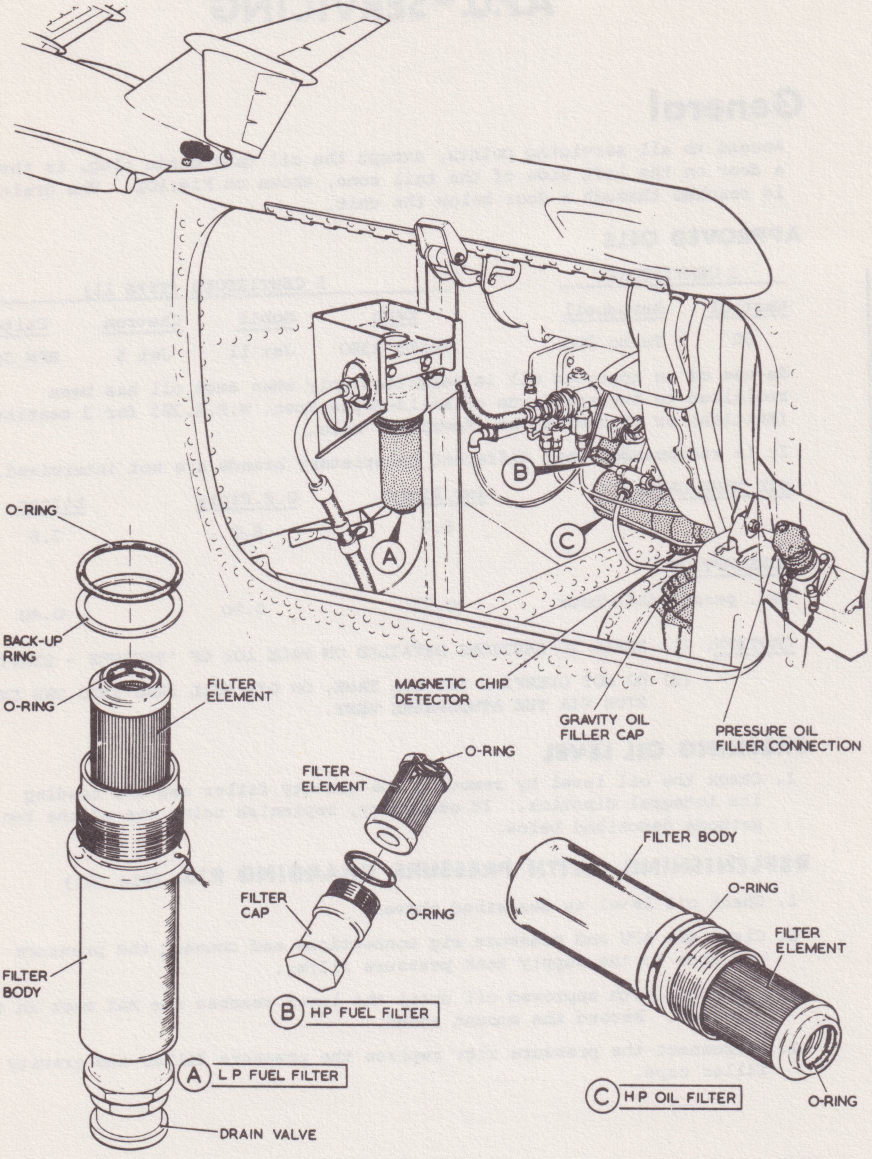
O-RING
BACK-UP RING
O-RING
FILTER ELEMENT
FILTER BODY
DRAIN VALVE
A L P FUEL FILTER
A
B
C
MAGNETIC CHIP DETECTOR
GRAVITY OIL FILLER CAP
PRESSURE OIL FILLER CONNECTION
O-RING
FILTER ELEMENT
FILTER CAP
O-RING
B HP FUEL FILTER
FILTER BODY
O-RING
FILTER ELEMENT
O-RING
C HP OIL FILTER
ABOO/4936A

A.P.U. Servicing Points
Figure 101

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REPLENISHING - GRAVITY METHOD (Fig.101)

1. Check oil level as previously described.
2. Add approved oil until level with the MAX mark on the dipstick. Record the amount added.
3. Replace the gravity filler cap.

NOTE: When re-filling a drained system, use either replenishing method; allow a brief period for air to vent from system then re-check and top-up as required.

Start and run the APU (1-9-2) for 3 minutes, then shut-down and top-up if necessary.

DRAINING

Open the access door beneath the APU and position a suitable container to collect the drained oil. Remove the tank drain plug. Remove the magnetic chip detector to drain the HP oil filter and vent the system.

HP OIL FILTER (Fig.101, Detail C)

The filter element is disposable and should be renewed at recommended maintenance periods or whenever found to be contaminated.

Drain filter, before removing the body and element, by removing the magnetic chip detector.

Replacement element (Part No.AiResearch 76149) includes an internal O-ring.

Oil-immerse element, thoroughly clean filter body and renew the external O-ring before re-fitting. After fitting, check and replenish oil as required.

MAGNETIC CHIP DETECTOR (Fig.101)

The detector attracts and retains small particles of steel released into the oil system, thus providing, on inspection, early warning of bearing failure.

Carefully immerse in white spirit before inspecting.

FUEL FILTERS (Fig.101, Details A and B)

The elements are disposable and should be renewed at recommended maintenance periods or whenever found to be contaminated.

Before removing filter body (or cap) ensure that APU FUEL VALVE indicator on the flight deck reads CLOSED, and trip LP BOOSTER PUMP circuit-breakers on Panels B and P (2-5-0).

Replacement elements, which include O-rings and must NOT be oiled, are:-

L.P. Filter	Bendix 038062
H.P. Filter	AiResearch 337-501-9001

After fitting, reset the booster pump circuit-breakers.

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